1946

Evaluation of safety factors in the industrial education shops of Davenport

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EVALUATION OF SAFETY FACTORS IN THE INDUSTRIAL EDUCATION SHOPS OF DAVENPORT

by

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A Thesis Submitted to the Graduate Faculty
for the Degree of

MASTER OF SCIENCE

Major Subject: Industrial Education

Iowa State College

1946

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I INTRODUCTION

It is the purpose of this study to apply the following measures of safety to the Industrial Education Shops of the Davenport Schools:

1. Iowa School Code
2. Iowa Industrial Code
3. Wisconsin Industrial Code
4. Industrial Safety Standards[1]

The Industrial Safety Standards, commonly known as "insurance regulations" are drawn from the codes of the American Standards Association, and the American Society of Mechanical Engineers. Governmental and fire underwriters codes and regulations have been incorporated in this handbook. Iowa schools operate under the School Sections of the Iowa Code, local industry and advisory committees think in terms of the industrial section of the Iowa Code. The underwriter fire inspectors are concerned with fire conditions only but they look critically at operating conditions in school shops. None of the foregoing codes or standards would be used by the cold calculating judgment of public opinion in case of a catastrophe. Schools should without legal compulsion desire to operate safely.

The three codes and the insurance regulations were applied to shop conditions tabulated as "Provisions for:" and also to the instructional equipment and hand tools of twenty shops in Davenport.

[1] Handbook of Industrial Safety, National Conservation Bureau, New York, New York - 1942

In each instance when a factor did not meet the code or standard, the identifying section of the code or regulation was recorded.

During the survey, substandard scores were applied separately to the mechanical installation and provision for service. To illustrate, a drill press which was not grounded was scored as substandard under the heading of "Provisions for: Electrical Equipment", while the same machine which had an unguarded belt was scored substandard under the heading of "Equipment - Drill Press."

Before the survey was made a tally sheet was prepared from the insurance regulations. Items not applicable were deleted.

To avoid the appearance of a discrepancy between the survey and the insurance regulations, those items deleted were shown with their regular heading but the subject matter was omitted.

II ELECTRICAL SHOPS (3 IDENTICAL SHOPS)

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect			26	17.6
Exhausts, Heavier than air		1489	8	28.3
Exhausts, Lighter than air				
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Electrical Shops					
1	Can, Waste				
1	Drill, Power				18.2
1	Grinder				
1	Motor + Dynamos				
1	Panel, Testing, A.C. & D.C.				
1	Panel, Testing, Fahnstock, Clips				
1	Transformer, 150W				
	Hand Tools				

III FOUNDRY

Provisions for:	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Acids				
Room Exits				
Electrical Equipment				
Electrical Disconnect				
Exhausts, Heavier than air				
Exhausts, Lighter than air		1490		28.11
Fire Extinguishers			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				
Personal Protections				4.6 4.1
Piping				16.3
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Foundry					
1	Crane, Swinging				
1	Furnace, Brass				28.11
1	Oven, Core				28.11
1	Vibrator				
	Hand Tools				

IV GENERAL METAL SHOPS (3 IDENTICAL SHOPS)

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				32.2
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect			26	17.6
Exhausts, Heavier than air		1489	8	28.23
Exhausts, Lighter than air		1490		28.11
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				16.3
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, General Metal Shops					
1	Can, Waste				
1	Cord, Extension				
2	Drill Presses 14"	—	1487	1	18.2
1	Drill Press, Delta, 17", 1 motor ½ H.P. 1725 RPM	—	1487	1	18.2
1	Drill, Portable Elect.				
1	Folder, Bar 30"				
1	Folder, Bar 20"				
1	Forming Roll				
1	Furnace, Tempering				
1	Furnace, Gas, Johnson-2 Burner				
5	Furnaces, Gas, Buzzers-2 Burner				
1	Furnace, Gas, 3-Burner Johnson				
1	Furnace, Gas, Automatic, Johnson				
1	Grinder, Floor			8	21.1
1	Grooving Machine				
1	Gutter-Beader				
1	Lathe, Metal		1487	1	18.2 17.6
1	Lathe, Wood		1487	1	18.2
1	Oven, Baking				

		Does not Meet Requirements		
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, General Metal Shops					
1	Setting Down Machine				
1	Shear, Cutting 4"				21.7
1	Shear, Slitting 3/16" Cap.				
1	Shear, Squaring				
1	Wiring Machine				
	Hand Tools				

V INDUSTRIAL ARTS MACHINE SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect			26	17.6
Exhausts, Heavier than air		1489	8	28.23
Exhausts, Lighter than air		1490		28.11
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				16.3
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Industrial Arts Machine Shop					
1	Drill, Floor, Canedy-Otto			1	18.2
1	Drill, Electric Thor				
1	Grinder			8	21.1
1	Lathe, Engine, 14", Swing South Bend				
3	Lathes, Engine, 13", Swing				
9	Lathes, Engine, 9", Swing				
1	Lathe, Engine, 11", Swing				
1	Lathe, Engine, 16-18" Swing				
1	Milling Machine		1487	1	18.2
1	Press, Mandrel				
1	Saw, Power				
1	Shaper, Milwaukee				
	Hand Tools				

VI VOCATIONAL MACHINE SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect			26	17.6
Exhausts, Heavier than air		1489	8	28.23
Exhausts, Lighter than air		1490		28.11
Fire Extinguishers			5618	17.16
First Aid				
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				16.3
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Vocational Machine Shop					
1	Grinder				
1	Press		1487	1	18.2
9	Lathes, Sebastian, Type H				
3	Lathes, 17", Super Regal				
1	Drill Press, 21" Canedy-Otto with accessories				
1	Drill, Radial, 5' Canedy-Otto				
1	Shaper, 12" Vernon H.D.				
1	Shaper, Cincinnati				
1	Mill, Vertical - Vernon				
1	Milling Machine, Vernon #0				
1	Milling Machine #3 Univ.				
1	Milling Machine K & T				
1	Planer, Cincinnati				18.4 21.82
1	Lathe, Turret, #2 Bardon & Oliver				
1	Saw, Hack, Marvel H. Sp.				
1	Surface Grinder #3B Abrasive				18.3
1	Grinder, Floor, Double End				
1	Grinder, Tool & Cutter				
1	Furnace, Heat Treat				
1	Grinder, #7A Dumore				
1	Crane, #5 Hill Acme				

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Vocational Machine Shop - Continued				
1 Grinder, Bench, Baldore #600				
1 Buffer, Baldore #450B				
1 Grinder, Tool #200 Baldore Carbide				
1 Parts Washer, #33				
Hand Tools				

VII TOOL AND DIE SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect				
Exhausts, Heavier than air				
Exhausts, Lighter than air				
Fire Extinguisher			5618	17.16
First Aid				
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				16.3
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Tool and Die Shop					
1	Shaper, 12" Hydraulic				
3	Presses, Drill, 14"				
1	Extractor, Tap				
1	Grinder, Hammond				
1	Powersaw, 6" x 6"				
1	Machine, Milling				
6	Lathes, Sebastian				
1	Filer, Grob Band, #3				
1	Borer, Jig				
1	Furnace, Tempering				
1	Furnace, Pot				
2	Furnace, Semi-Muffle				
1	Filer, Oliver Die				
1	Bandsaw, Doall, Metalmaster				
1	Shaper, Steptoe				
1	Vertical Mill & Slotter	1487	1		18.2
1	Mill, Vertical, All-Angle Fray				
1	Grinder, Surface				
1	Grinder, Tool & Cutter				
1	Planer, Putnam 24"				
1	Grinder, Cylindrical #3				

		Does not Meet Requirements		
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Tool and Die Shop - Continued					
1	Grinder, Profile				
1	Press, Radial Drill				
1	Compressor, Air				
1	Powersaw				
1	Fan, Exhaust				
1	Blower, Pressure				
1	Lathe, Model 9B				
2	Presses, Drill				
1	Press, Arbor				
	Hand Tools				

VIII ACETYLENE WELDING SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				
Electrical Disconnect				
Exhausts, Heavier than air				
Exhausts, Lighter than air				
Fire Extinguisher			5618	17.16
First Aid				
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Acetylene Welding Shop					
8	Outfits Acetylene Welding				
8	Outfits Lead Burning				
	Hand Tools				

IX ARC WELDING SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14
Electrical Disconnect				
Exhausts, Heavier than air		1489	8	28.23
Exhausts, Lighter than air		1490		28.11
Fire Extinguisher			5618	17.16
First Aid				
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Arc Welding Shop					
1	Welder, Arc Master				
1	Welder, Marquette, 100 Amp.				
1	Generator, Hobart, D.C.				
1	Generator, Flexarc West				
1	Welder, Flexarc				
1	Generator, Flexarc				
1	Welder, Lincoln D.C.				
1	Welder, Lincoln D.C.				
1	Welder, Sight Feed				
1	Welder, Sight Feed				
1	Welder, Marquette A.C.				
1	Welder, Will Weld				
1	Welder, Sight Feed, A.C.				
1	Welder, Spot				
1	Shear, Cutting				
1	Grinder, Floor, U.S.				
1	Welder, Hobart				
1	Welder, Lincoln, D.C.				
1	Welder, G.E.				
1	Fan, Exhaust				
1	Welder, Marquette A.C.				17.7

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Arc Welding Shop - Continued				
1 Welder, Smith, A.C.				
1 Monitor, Welding, Smithway				
Hand Tools				

X BENCH WOODWORK (3 IDENTICAL SHOPS)

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect			26	17.6
Exhausts, Heavier than air		1489	8	28.23
Exhausts, Lighter than air				
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				5.1
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				16.3
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurence Regulations
Equipment, Bench Woodwork					
1	Gas plate, single burner				
1	Grinder, Pedestal				
1	Heater, glue, electric				
1	Jointer, 6"				
1	Lathe, Wood				
1	Router, shaper				20.36
1	Sander, belt				20.35
1	Saw, Band				20.21
1	Saw, scroll, multi speed				
1	Shaper, reversible				20.36
1	Soldering iron, electric				
1	Waste can				
	Hand Tools				

XI PATTERNMAKING SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect			26	17.6
Exhausts, Heavier than air		1489	8	28.23
Exhausts, Lighter than air				
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				29.1
Passageways			14	5.1
Illumination				7.12
Personal Protections				
Piping				
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Patternmaking Shop					
1	Attachment, Grinder				
1	Band saw				
1	Can, Waste, 19" Dia. x 25				
1	Can, Waste, 17" Dia. x 19"				
1	Dresser, Emery Wheel				
1	Generator, Motor				17.11
1	Ladder				9.5
9	Lathes, Fay & Egan				
1	Lathe, Oliver				
2	Lathes, Fay & Egan				
2	Lathes, Fay & Egan				
2	Lathes, Yates-American				
1	Sander, Yates-American				
1	Saw, Crescent				
1	Trimmer, Wood				
	Hand Tools				

XII AUTOMOTIVE SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				52.2
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect			26	17.6
Exhausts, Heavier than air				
Exhausts, Lighter than air		1490		28.11
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				7.12
Personal Protections				4.6
Piping				
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements			
		Iowa School Code	Iowa Ind. Code	Misc. Ind. Code	Insurance Regulations
Equipment, Automotive Shop					
1	Drill Press			1	18.2
1	Grinder, Bench Type				
16	Motor Trunions				
1	Run in Stand				
1	Valve Grinder				
	Hand Tools				

XIII PART TIME SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14 17.27
Electrical Disconnect			26	17.6
Exhausts, Heavier than air		1489	8	28.25
Exhausts, Lighter than air		1490		28.11
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				
Passageways			14	5.1
Illumination				
Personal Protections				4.6
Piping				16.3
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements		
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance
Equipment, Part Time Shop					
1	Glue Pot				
1	Grinder, Electric and Motor				
1	Jig Saw				
1	Lathe, Wood Stand and Motor				
1	Machine, Shoe				
1	Shaper, Stanley, Router Shaper				
1	Saw, Band				20.21
	Hand Tools				

XIV GRAPHIC ARTS SHOP

Provisions for:	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Acids				
Room Exits				
Electrical Equipment				
Electrical Disconnects				
Exhausts, Heavier than air				
Exhausts, Lighter than air				
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				29.1
Passageways			14	5.1
Illumination				7.12
Personal Protections				
Piping				
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1482		1.4

		Does not Meet Requirements		
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Graphic Arts Shop					
1	Press, Proof, Poco				
	Hand Tools				

XV PRINTING SHOP

	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Provisions for:				
Acids				
Room Exits				
Electrical Equipment				17.14
Electrical Disconnect			26	17.6
Exhausts, Heavier than air				
Exhausts, Lighter than air				
Fire Extinguisher			5618	17.16
First Aid				2.1
Housekeeping and Storage of Materials				29.1
Passageways			14	5.1
Illumination				7.12
Personal Protections				
Piping				16.3
Sanitation				
Safety Meetings				1.22
Safety Inspections				1.21
Records		1492		1.4

		Does not Meet Requirements		
		Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Equipment, Printing Shop					
2	Cans, Pint, Bensine				
2	Cans, Quart, Benzine				
3	Cans, Gallon, Gas				
1	Intertype				
1	Press, Campbell-Cylinder				
1	Press, C & P Gordan Press				
1	Press, C & P Gordan Press				
1	Stapler				
1	Trimmer				
	Hand Tools				

XVI DISCUSSION OF PREVAILING SUBSTANDARD MACHINES AND SERVICES

The Industrial Education shops of the Independent School District of Davenport, when judged by the school sections of the Code of Iowa, have no substandard conditions.

If the same installations were the property of a private industry operating under the industrial sections of the Code of Iowa, there would be 58 substandard conditions to be corrected.

If the same installations were the property of private industry operating in the neighboring State of Wisconsin there would be 88 substandard conditions to be corrected.

The same installations, if the property of private industry, operating in Iowa would probably require the correction of 291 substandard conditions so that full insurance coverage could be secured.

Table 1

Machines and Services Failing to Meet Requirements

Factors	Does not Meet Requirements			
	Iowa School Code	Iowa Ind. Code	Wisc. Ind. Code	Insurance Regulations
Machines and Hand Tools	0	15	19	49
Provisions for Services	0	43	69	242
Total	0	58	88	291

Table 2

Substandard Machine and Hand Tools

Equipment	Does not Meet Requirements					
	Iowa School Code		Iowa Ind. Code		Wisc. Ind. Code	Insurance Regulations
	No.	Sec.	No.	Sec.	No.	Sec.
Drills, Power, Portable					3	18.2
Drill Press	7	1487	8	1	9	18.2
Furnaces, Brass					1	28.11
Generator, Motor					1	17.11
Grinders, Floor			3	8	4	21.1
Ladder					1	9.5
Lathes, Metal	3	1487	3	1	3	18.2
Lathes, Wood	3	1487	3	1	3	18.2
Milling Machine	1	1487	1	1	1	18.2
Oven, Core					1	28.11
Planer					1	21.82
					1	18.4
Routers					3	20.36
Sanders					3	20.35
Saws, Band					4	20.21
Shapers					3	20.36
Shears					3	21.7
Surface Grinder					1	18.3
Trimmer, Paper					1	22.21
Vertical Mill	1	1487	1	1	1	18.2
Welder, A.C.					1	17.7
Hand Tools						
Total	15		19		49	

Table 3

Substandard Provisions for Service

Provisions for:	Does not Meet Requirements					
	Iowa School Code		Iowa Ind. Code		Wisc. Ind. Code	Insurance Regulations
	No.	Sec.	No.	Sec.	No.	Sec.
Acids					4	32.2
Room Exits					0	
Electrical Equipment					16	17.14
					14	17.27
Electrical Disconnects			15	26	15	17.6
Exhausts, Heavier than air	14	1489	14	8	14	28.5
Exhausts, Lighter than air	9	1490			9	28.11
Fire Extinguisher			20	5618	20	17.16
First Aid					16	2.1
Housekeeping and					3	5.1
Storage of Materials					3	29.1
Passageways			20	14	20	5.1
Illumination					18	7.12
Personal Protections					17	4.6
					1	4.1
Piping					12	16.3
Sanitation					0	
Safety Meetings					20	1.22
Safety Inspections					20	1.21
Records	20	1492			20	1.4
Total	43		69		242	

A comparison of the substandard conditions shown by the three Codes and the Insurance Regulations indicate that the Insurance Regulations are more critical, specific, and restrictive. Therefore, the conclusions and recommendations of corrective measures to be taken will be discussed in the order of their frequency of occurrence.

If a specific recommendation is based on Insurance Regulations, the section number of the regulation appears in parenthesis following the close of the statement.

Table 4

Substandard Equipment

Equipment	Cases	Order	Insurance Regulations
Drill Press	9	1	18.2
Saw, Band	4	2	20.21
Grinder, Floor	4	3	21.1
Drill, Power, Portable	3	4	18.2
Lathe, Metal	3	5	18.2
Lathe, Wood	3	6	18.2
Sander	3	7	20.35
Router	3	8	20.36
Shaper	3	9	20.36
Shear	3	10	21.7
Ladder	1	11	9.5
Welder, A.C.	1	12	17.7
Generator, Motor	1	13	17.11
Milling Machine	1	14	18.2
Vertical Mill	1	15	18.2
Surface Grinder	1	16	18.3
Planer	1	17	18.4
Planer	1	18	21.82
Trimmer, Paper	1	19	22.21
Furnace, Brass	1	20	28.11
Oven, Core	1	21	28.11
Hand Tools	0	22	
Total	49		

Recommendations - Equipment

1. Drill Press. The pulley is not fully guarded. Manufacturer has since provided full guards. Guards should be purchased. (18.2)
2. Saw, Band. The upper and lower wheels are not guarded on the backs. Guards should be constructed to completely enclose the travel of the blade excepting that portion between the guide and table. (20.21)
3. Grinder, Floor. The hoods do not completely enclose the wheels. Protection hoods should cover both sides and peripheral surface

excepting necessary point of operation. Hoods of later design should be secured from the manufacturer. (21.1)

4. Drill, Power, Portable. The pulleys are not fully guarded. Guards should be built to give full coverage. (18.2)

5. Lathe, Metal. The pulleys are not fully guarded. Guards should be built. (18.2)

6. Lathe, Wood. The pulleys are not fully guarded. Guards should be built. (18.2)

7. Sander. The drums are not guarded. Guards should be built. (20.35)

8. Router. The cutting head is not enclosed by an adjustable guard. An adjustable guard should be built. (20.36)

9. Shaper. The cutting head is not enclosed by an adjustable guard. An adjustable guard should be purchased. (20.36)

10. Shear. The guard does not prevent the hands of the operator from entering the zone of the knife travel. A guard should be built. (21.7)

11. Ladder. The portable ladder has no provision to keep the feet from slipping. A ladder less than 30 feet in length should be equipped with a non-slip base. Non-slip bases should be purchased. (9.5)

12. Welder, A.C. The wiring is not enclosed in rigid conduit. Flexible wiring should be removed and re-wired through conduit. (17.7)

13. Generator, Motor. The commutator of the generator is open. A guard should be built. (17.11)

14. Milling Machine. The pulley is not guarded. A guard or fence should be built. (18.2)

15. Vertical Mill. The pulley is not fully guarded. A complete guard should be built. (18.2)

16. Surface Grinder. The horizontal exposed belt is less than 6 feet from the floor. A guard should be built. (18.3)

17. Planer. The gears on the clapper box adjustment are exposed. A guard should be built. (18.4)

18. Planer. The planer bed does not have a cover to prevent shear between the bed and the carriage. A set of covers should be built and installed between openings. (21.82)

19. Trimmer, Paper. There is no guard to prevent operators hands from entering the zone of the knife travel. A guard should be built and installed. (21.21)

20. Furnace, Brass. There is no exhaust to remove gases. An escape exhaust should be built and installed. (28.11)

21. Oven, Core. There is no exhaust to remove gases. A vent from the oven to the window should be built. (28.11)

Table 5

Substandard Provisions for Service

Provisions for:	Cases	Order	Insurance Regulations
Records	20	1	1.4
Safety Inspection	20	2	1.21
Safety Meetings	20	3	1.22
Passageways	20	4	5.1
Fire Extinguisher	20	5	17.16
Illumination	18	6	7.12
Personal Protection	17	7	4.6
Electrical Equipment (Identification Circuits)	16	8	17.14
First Aid	16	9	2.1
Electrical Disconnect	15	10	17.6
Exhausts, Heavier than air	14	11	28.3
Electrical Equipment, Grounding	14	12	17.27
Piping	12	13	16.3
Exhausts, Lighter than air	9	14	28.11
Acids, Storage	4	15	32.2
Housekeeping and Storage of Materials	3	16	29.1
" " " "	3	17	5.1
Personal Protection	1	18	4.1
Room Exits	0	19	8.
Total		242	

Recommendations - Provisions for Service

1. Records. There is no comprehensive reporting system of accidents. The National Safety Council, 20 North Wacker Drive, Chicago, Illinois during a personal interview with candidate, admitted the national absence of a comprehensive reporting system due to:

   a. Lack of comparison.

   b. The difference in waiting periods for compensation by states.

   c. The lack of uniformity of reporting.

   d. The lack of uniformity of coverage by law.

e. The lack of a definition of responsibility.

f. That some states tabulate reported cases while others tabulate compensation cases.

A standard form should be developed and adopted. It is recommended that some future study be devoted to this problem. (1.4)

2. Safety Inspection. There is no regular safety inspection. Such inspections have been made periodically and a part of general supervision. Regular and specific safety inspection should be made. (1.21)

3. Safety Meetings. There is no definite schedule of safety meetings conducted by shop instructors. A good safety program cannot be secured by a 15 minute unit once or twice a semester. A definite safety unit should be organized and regularly presented.

Occasionally a safety film has been shown. Future showing of films should be preceded by proper presentation of the problem. Following the film there should be a discussion and then testing to complete the unit. Safety films should be more than entertainment. (1.22)

4. Passageways. The aisles and clearance about the machines are crowded. The operational areas about the machines should be clearly marked. The crowded conditions in the three machine shops cannot be corrected until larger quarters are available. If for no other reason than safety alone, a new building should be built as soon as possible. (5.1)

5. Fire Extinguisher. There are an insufficient number of fire

extinguishers. There should be one 2½ gallon extinguisher for each 2500 square feet. The types of extinguishers required are as follows:

Type A - for carbonaceous materials.

Type B - for oils and volatile substances.

Type C - for electrical equipment.

The type of extinguisher in one location was found to be incorrect. A combination Type A-C fire extinguisher should be purchased. In all of the remaining cases extinguishers were hanging in the hallway outside of the shop door. (17.16)

6. Illumination. The illumination, when measured, was not higher than 10 foot candles on 5 different days. All shops should be surveyed for lighting recommendations and proper installations made. (7.12)

7. Personal Protection. The goggles provided are disregarded and not used. The principal objection to the use of goggles is sanitation. Goggles which have been worn should not be issued for further use until they have been sterilized. Goggles should be issued to individuals as personal equipment to be retained by the individual during the school year. (4.6)

8. Electrical Equipment (Identification Circuits). Different voltages, although protected by polarized plugs, are not identified by labels. Permanent labels should be installed. (17.14)

9. First Aid. There is an absence of first aid kits in the shops. This is due to a policy adopted by the School Board upon the request of the school physician a number of years ago "that first aid be

administered in the principal's office." It is presumed that when this policy went into effect that accidents walked to the principal's office to happen. Sixteen first aid kits should be installed. (2.1)

10. Electrical Disconnect. All of the fuses are not arranged so that they can be disconnected by a switch. A main switch should be wired to permit a complete disconnect of all equipment in the shop. (17.6)

11. Exhausts, Heavier than air. There are no exhausts on grinders. Air cleaning units should be installed on all dry grinders. (28.5)

12. Electrical Equipment, Grounding. The machines operating on a voltage higher than 150 volts have no ground wire to frame. Under certain conditions a few amperes could be fatal. Ground wires should be installed. (17.27)

13. Piping. The materials carried in pipes are not identified. All lines of pipe should be painted for identification as follows:

Fire protection equipment - Red

Dangerous material - Yellow or Orange

Safe materials - Green (or achromatic colors black, white, gray, or aluminum)

Protective materials - Bright Blue (16.5)

14. Exhausts, Lighter than air. Vapors and gases are not vented from the working level to an outside source. Hoods should be built and installed. (28.11)

15. Acids, Storage. Acids stored in carboys and large bottles are

not removed by a syphon. A rubber tube syphon with a suction ball should be purchased. (32.2)

16. Housekeeping and Storage of Materials. Flammable liquids are not stored in safety cans. Three safety cans should be purchased. (29.1)

17. Housekeeping and Storage of Materials. Oily waste is not placed in self-closing metal containers. Three waste cans should be purchased. (5.1)

18. Personal Protection. Aprons and gloves of heat resistant material are not worn near heat treating units. Chrome leather, heat resisting aprons and gloves, should be provided for heat treat room. (4.1)

XVII SUMMARY

The survey of the Industrial Education Shops of the Davenport, Iowa Schools was made to evaluate the safety factors involved. Four separate codes and standards were used as criteria. The measures used were the School section of the Iowa Code, Industrial section of the Iowa Code, Wisconsin Industrial Code, and the Industrial Safety Standards, commonly known as the "Insurance Regulations." Substandard conditions in the mechanical installations and provisions for service in all shops were scored separately, under each of the criteria.

The equipment and the provision for service in twenty shops were surveyed. In the intermediate schools the installations inspected were three electrical shops, three general metal shops, and three bench woodwork shops. In the high school those inspected were the foundry, industrial arts machine shop, vocational machine shop, tool and die shop, acetylene and arc welding shops, patternmaking shop, automotive shop, graphic arts shop, and printing shop. In the part-time general continuation school one general shop was inspected.

The survey indicated that under the School section of the Iowa Code there were probably no substandard conditions in the Industrial Education Shops of Davenport. However, the Industrial section of the Iowa Code designates 58 substandard conditions, but 68 were recognized under the Industrial Code of Wisconsin. The Insurance Regulations pointed to 291 observed substandard conditions. Under the Iowa Code it is regrettable that higher standards are required to be maintained in industry than in school shops. If the same installations were

operated by private industry the 291 substandard conditions would require correction before full insurance coverage could be secured.

A comparison of the substandard conditions shown by the three Codes and the Insurance Regulations indicate that the Insurance Regulations are the more critical, specific, and restrictive. The School sections of the Iowa Code should be rewritten to conform to Insurance Regulations. Until they are rewritten school administration should recognize the Insurance Regulations as operative standards. The 291 substandard conditions should be corrected.

The absence of a comprehensive reporting system of accidents is due partially to the lack of uniformity of reporting on a national basis. Some future study should be devoted to the development of uniform national accident reporting.

The School sections of the Iowa Code should require use of a uniform accident report. Also class demonstrations on the use of fire extinguishers should be required of all schools.

To establish a safety program in Iowa Schools and to avoid "lip service," teacher training institutions should require the satisfactory completion of a safety course of all graduates.

APPENDICES

A. Iowa School Code. Section 1529. Cleaning or operating machinery. The following acts shall be unlawful:

1. Directing or permitting any boy under sixteen or girl under eighteen years of age to clean machinery while it is in motion.
2. Permitting any boy or girl under sixteen years of age to operate or assist in operating any freight or passenger elevator.
3. Permitting any boy or girl under sixteen years of age to operate or assist in operating dangerous machinery; but this provision shall not apply to pupils working under an instructor in manual training departments in public schools of the state or under an instructor in a school, shop, or industrial plant, in a couse of vocational education approved by the state board for vocational education.
    1. Negligence per se. The statutory provision that the owner or person in charge of a manufacturing or other establishment where machinery is used shall not allow persons under a specified age to assist in cleaning machinery while in motion renders a violation of such provisions negligence per se. Bromberg v Evans L. Co., 154-38; 111 NW 417.
    2. Voluntary meddler. This section has no application to a case where a child under said age, and of average intelligence, voluntarily departs from his known and understood line of duty, without the consent of the master, and is injured while operating such dangerous machinery. Haller V Quaker Oats Co., 181-389; 164 NW 863.
    3. Assumption of risk. The doctrine of assumption of risk is not to be invoked to defeat recovery by employees of immature years for whose protection the statute is specially designed. Woolf v Nauman Co., 128-261; 103 NW 785; Bromberg v Evans L. Co., 154-38; 111 NW 417.

B. Iowa Industrial and Health Codes

1482. Enforcement. It shall be the duty of the commissioner of labor of the state, and the mayor and chief of police of every city or town, to enforce the provisions of this chapter. (SS15, Section 4999-a5; C24,27,31, Section 1482.)

1483. Water-closets--separate for each sex. Every manufacturing or mercantile establishment, workshop, or hotel in which five or more persons are employed, shall be provided with a sufficient number of water-closets, earth closets, or privies for the reasonable use of the persons employed therein, which shall be properly screened and ventilated and kept at all times in a clean condition and free from all obscene writing or marking; and such water-closets or privies shall be supplied in the proportion of at least one to every twenty employees; and if women or girls are employed in such establishment, the water-closets, earth closets, or privies used by them shall have separate approaches and be separate and apart from those used by the men or boys. (S13, Section 4999-a1; C24,27,31, Section 1483.)

1484. Washing facilities. In factories, mercantile establishments, mills, and workshops adequate washing facilities shall be provided for all employees; and when the labor performed by the employees is of such a character as to require or make necessary a change of clothing, wholly or in part, by the employees, there shall be provided a dressing room, or rooms, lockers for keeping clothing, and adequate washing facilities separate for each sex, and no person or persons shall be allowed to use the facilities assigned to the opposite sex. A sufficient supply of water suitable for drinking purposes shall be provided. (S13, Section 4999-a1; C24,27,31, Section 1484.)

1485. Seats for female employees. All employers of females in any workshop, mercantile, or manufacturing business or establishment shall provide and maintain suitable seats, when practicable, for the use of such female employees, at or beside the counter or work-bench where employed, and permit the use thereof by such employees to such extent as the work engaged in may reasonably admit. (C97, Section 4999; C24,27,31, Section 1485.)

1486. Steam and water guages and valves. Every person owning or operating a steam boiler in this state shall provide the same with steam guage, safety valve, and water guage, and keep the same in good order. (C73, Section 4064; C97, Sections 5025, 5026; S13, Section 4999-a2; C24, 27, 31, Section 1486.)

1487. Safety appliances. It shall be the duty of the owner, agent, superintendent, or other person in charge of any workshop, manufacturing or other industrial establishment or concern operated by machinery, either in a fixed location or when portable and moved from place to place therein in carrying on such industry, so far as practicable, to install and keep in order belt shifters or other safe mechanical means for throwing belts on and off pulleys, install loose pulleys, and protect, by guards or housing, all gearing, cogs, belting, shafting, tumbling rods, universal or knuckle joints, set screws, saws, planes, and other machinery, when so located or used that employees may receive injury thereby. The provisions of this chapter shall not apply to agricultural pursuits. (C73, Section 4064; C97, Section 5025; S13, Section 4999-a2; C24,27,31, Section 1487.)

1488. Removal of guards or appliances. When any person shall remove any guard or safety appliance from any machine or other equipment, or shall so adjust or place the same as to destroy or impair its use in preventing bodily injury or safeguarding health, for the purpose of enabling the employee operating said machine to perform any special work that cannot otherwise be performed, it shall be the duty of said employee or employer to immediately replace it after such special work has been completed. (SS15, Section 4999-a5; C24,27,31, Section 1488.)

1489. Blowers and pipes for dust. All persons, companies, or corporations operating any factory or workshop where emery wheels or emery belts of any description, or tumbling barrels used for tumbling or polishing castings, are used, shall provide the same

with blowers and pipes of sufficient capacity, placed in such a manner as to protect the person or persons using same from the particles of dust produced or caused thereby, and to carry away said particles of dust arising from or thrown off such wheels, belts, and tumbling barrels, while in operation, directly to the outside of the building, or to some receptacle placed so as to receive or confine such particles of dust; but grinding machines upon which water is used at the point of grinding contact, and small emery wheels which are used temporarily for tool grinding are not included within the provisions of this section, and the shops employing not more than one man at such work may, in the discretion of the labor commissioner, be exempt from the provisions hereof. (S13, Section 4999-a4; C24,27,31, Section 1489.)

1490. Pipes and flues for gases. Any factory, workshop, printshop, or other place where molten metal or other material which gives off deleterious gases or fumes is kept or used shall be equipped with pipes or flues so arranged as to give easy escape to such gases or fumes into the open air, or provided with other adequate ventilators. (S13, Section 4999-a4; C24,27,31, Section 1490.)

1491. Notice of violation. When the commissioner or his inspector shall discover or have reason to believe that any provision of sections 1483 to 1490, inclusive, is being violated, he shall give to the person, company, corporation, or the manager or superintendent thereof, a notice in writing to comply with such provision within a reasonable time to be fixed in said notice and which time shall be of not less than seven nor more than thirty days' duration, except that such time may be extended by the commissioner for good cause shown.

In fixing the time in such notice, the commissioner shall take into consideration the nature of the failure or defect constituting the violation, the danger to be apprehended therefrom, and the probable length of time and amount of labor required to remedy or cure such defect. (SS15, Section 4999-a5; C24,27,31, Section 1491.)

1492. Record of accidents. Manufacturers, manufacturing corporations, proprietors, or corporations operating any mercantile establishment, mill, workshop, business house, or mine, other than those subject to inspection by the state mine inspector, shall keep a careful record of any accident occurring to an employee while at work for the employer, when such accident results in the death of the employee or in such bodily injury as will or probably may prevent him from returning to work within two days thereafter. The said record shall at all times be open to inspection by an inspector of the bureau of labor. (S13, Section 2477-1a; C24,27,31, Section 1492.)

1493. Report of accidents--evidence. Within forty-eight hours after the occurrence of an accident, the record of which is required to be kept, a written report thereof shall be forwarded to the commissioner of labor and said commissioner may require further and additional report to be furnished him should the

first report be by him deemed insufficient. No statement contained in any such report shall be admissible in any action arising out of the accident therein reported. (S13, Section 2477-1a; C24,27,31, Section 1493.)

1494. Penalties (Not relevant.)

1495. Assumption of risks. In all cases where the property, works, machinery, or appliances of an employer are defective or out of repair, and where it is the duty of the employer from the character of the place, work, machinery, or appliances to furnish reasonably safe machinery, appliances, or place to work, the employee shall not be deemed to have assumed the risk, by continuing in the prosecution of the work, growing out of any defect as aforesaid, of which the employee may have had knowledge when the employer had knowledge of such defect, except when in the usual and ordinary course of his employment it is the duty of such employee to make the repairs, or remedy the defects. Nor shall the employee under such conditions be deemed to have waived the negligence, if any, unless the danger be imminent and to such extent that a reasonably prudent person would not have continued in the prosecution of the work; but this statute shall not be construed so as to include such risks as are incident to the employment; and no contract which restricts liability hereunder shall be legal or binding. (S13, Section 4999-a3; C24,27,31, Section 1495.)

C. Extracts From Wisconsin Industrial Commission Law

Definition of Employment and Places of Employment

The phrase "place of employment" shall mean and include every place, whether indoors or out or underground and the premises appurtenant thereto where either temporarily or permanently any industry, trade or business is carried on, or where any process or operation, directly or indirectly related to any industry, trade or business, is carried on, and where any person is directly or indirectly, employed by another for direct or indirect gain or profit, but shall not include any place where persons are employed in private domestic service or agricultural pursuits which do not involve the use of mechanical power.

The term "employment" shall mean and include any trade, occupation or process of manufacture, or any method of carrying on such trade, occupation, or process of manufacture in which any persons may be engaged, except in such private domestic service or agricultural pursuits as do not involve the use of mechanical power. (Sec. 101.01).

Duties of Employers

Every employer shall furnish employment which shall be safe for the employes therein and shall furnish a place of employment which shall be safe for employes therein and for frequenters thereof and shall furnish and use safety devices and safeguards, and shall adopt and use methods and processes reasonably adequate to render such employment and places of employment safe, and shall do every other

thing reasonably necessary to protect the life, health, safety, and welfare of such employes and frequenters. (Sec. 101.06).

Duties of Employes

No employe shall remove, displace, damage, destroy or carry off any safety device or safeguard furnished and provided for use in any employment or place of employment, nor interfere in any way with the use thereof by any other person, nor shall any such employe interfere with the use of any method or process adopted for the protection of any employe in such employment or place of employment or frequenter of such place of employment, nor fail or neglect to do every other thing reasonably necessary to protect the life, health, safety or welfare of such employes or frequenters. (Sec. 101.07. (2).)

Penalties

If any employer, employe, owner, or other person shall violate any provisions of sections 101.01 to 101.15, inclusive, of the statutes, or shall do any act prohibited in sections 101.01 to 101.29, inclusive, or shall fail or refuse to perform any duty lawfully enjoined, within the time prescribed by the commission, for which no penalty has been specifically provided, or shall fail, neglect or refuse to obey any lawful order given or made by the commission, or any judgment or decree made by any court in connection with the provisions of sections 101.01 to 101.29, inclusive, for each such violation, failure or refusal, such employer, employe, owner or other person shall forfeit and pay into the state treasury a sum not less than ten dollars nor more than one hundred dollars for each such offense. (Sec. 101.28.)

Manufacturers' Responsibility

No machine, mechanical device, or steam boiler shall be installed or used in this state which does not fully comply with the requirements of the laws of this state enacted for the safety of employes and frequenters in place of employment and public buildings and with the orders of the Industrial Commission adopted and published in conformity with sections 101.01 to 101.28, inclusive, of the statutes. Any person, firm, or corporation, violating the provisions of this act shall be subject to the forfeitures provided in sections 101.18 and 101.26 of the statutes. (Sec. 101.30.)

Order A--Definitions.

Guarded. When used in these orders the term "guarded" unless otherwise specifically provided, shall mean so covered, fenced, or enclosed that a person in the course of employment is not liable to come in contact with the point of danger and be injured.

Exposed to Contact. When used in these orders, the term "exposed to contact", unless otherwise specifically defined, shall mean that the location of the mechanical contrivance is such that it is liable to cause an accident to a person while in the course of employment.

Order B--Standards and Specifications.

(1) Railings and Toeboards. Where standard railings and toeboards are called for in these orders, they shall conform to the following specifications:

(a) Railings shall be 42 inches in height except where otherwise specified and shall be equipped with toeboards unless the space between the lower rail and floor is filled with material as specified in (b).

(b) They shall be of substantial construction, shall be permanently fastened in place, and shall be smooth and free from protruding nails, bolts and splinters. An intermediate rail shall be provided between top rail and the floor, unless this space is filled with substantial wire mesh work, expanded metal, or other suitable material complying with the requirements of B-2

(c) If constructed of pipe, the inside diameter of the pipe shall not be less than 1½ inch.

(d) If constructed of metal shapes or bars, each part shall have a cross section at least equal in strength to that of a 1½" x 3/16" angle.

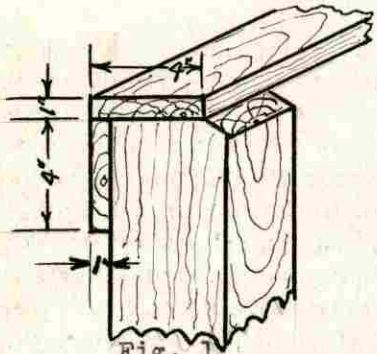


Fig. 1

(e) If constructed of wood, the posts shall not be smaller than the sizes commercially known as 2" x 4" or 3" x 3". The top rail shall be at least as large as the size known as 2" x 4", unless it is constructed in the manner shown in Fig. 1. The dimensions shown in Fig. 1 are the nominal size, and the finished size after planing is usually only about 3 3/4" x 15/16". The intermediate rail shall not be smaller than the size commercially known as 1" x 4".

(f) Posts and uprights shall be spaced not more than 8 feet apart.

(g) Toeboards shall be at least 4 inches in height and be constructed of wood, metal, metal grill with openings not exceeding 1 inch or other suitable material.

(h) Intermediate rails and toeboards, and top rails which are attached to side of posts, shall be placed on the side of the posts away from the engine, belt, floor opening, etc., to be guarded, so that any blow or pressure against them will be taken up by the posts instead tending to push the rails away from the posts.

(2) Guards.

(a) If guards are made of wire mesh work, perforated or expanded metal, crossed strips or bars of wood or metal, etc., the width or diameter of the holes shall not exceed 2 inches (see note following). If parallel strips or bars of wood or metal are used, the space between them shall not exceed 1 inch.

There shall be no openings more than ½ inch in width or diameter within 4 inches of any gear, belt, pulley or flywheel, or other dangerous moving part. Wood slats shall be smooth and free from splinters, and the holes in perforated or expanded metal shall be free from sharp, cutting edges.

Note: If the material of which the guard is constructed has openings wider than ½ inch, it shall be covered at all points within 4 inches of belts, etc., with wire mesh work or sheet metal or some other suitable material having no openings wider than ½ inch. If the hole is diamond shape, the width shall be measured along one side of the opening. If the hole is oblong, the greatest dimension shall not exceed that specified above for "width."

(b) The thickness of material used for guards shall not be less than is specified in the following table:

Material	A Clearance from Moving Part at all Points	B Largest Mesh or Opening Allowable	C Minimum Guage (U.S. Stand.) or Thickness
Woven Wire	Under 4"	½"	½"--#16
	4"--15"	2"	2"--#12
Expanded Metal	Under 4"	½"	½"--#18
	4"--15"	2"	2"--#13
Perforated Metal	Under 4"	½"	½"--#20
	4"--15"	2"	2"--#14
Sheet Metal	Under 4"	----	#22
	4"--15"	----	#22
Wood or Metal Strip Crossed	Under 4"	½"	Wood 3/4" Metal #16
	4"--15"	2"	Wood 3/4" Metal #16
Wood or Metal Strip not Crossed	Under 4"	½" width	Wood 3/4" Metal #16
	4"--15"	1" width	Wood 3/4" Metal #16
Solid Wood*			

*If plywood is used it shall be not less than 3/8" thick and not less than 3 ply.

Note 1: If the width or diameter of the opening is less than ½ inch, the thickness of the material shall be at least as great as is specified above for a ½ inch opening.

Note 2: The material commonly known as "chicken wire" is not suitable for guards and does not meet the requirements of this section.

(c) The supporting frames shall be of substantial construction, such as angles varying from 1" x 1" x 1/8" to 1½" x 1½" x 3/16", or iron pipe with inside diameter varying from 3/4 inch to 1½ inch, according to the weight of the filling material, the size of the panels, and the exposure of the guard to collision with trucks, etc. Any panel which measures more than 42 inches in both width and length shall be substantially supported across its narrowest dimension at intervals of not more than 42 inches.

(d) The filling material shall be bolted, riveted, or otherwise securely attached to the frame in such a manner that no sharp points or edges will be exposed. Bolts should be at least 3/16 inch in diameter and should be spaced not more than 10 inches apart. Flat bars or strips used for clamps should not be smaller than 3/4" x 1/8" if of iron, or 1" x 1" if of wood. Perforated or sheet metal may be spot-welded to angle iron frames.

(e) Guards shall be securely and permanently fastened in place, except as specifically otherwise provided.

Order 1--Belts, Pulleys, Etc.

Note: The provisions of this order shall cover belts, chains, cables and ropes together with pulleys, sprockets and sheaves in connection therewith and for purpose of simplification shall be referred to as belts and pulleys.

(1) All vertical and inclined belts within 6 feet of floor or platform level and all pulleys and all horizontal belts within 7 feet of floor or platform level, except belts that are 1 inch or less in width and single round belts ½ inch or less in diameter, that move so slowly and are so located that there is no possibility of danger, shall be completely enclosed or effectively guarded. Belts protected by railings shall be guarded in accordance with Order B-1. Belts protected by guards other than railings shall be guarded in accordance with Order B-2.

Vertical and Inclined Belts

(2) If the guard is within 4 inches of a belt or pulley, it shall extend from the floor or platform level to a height of at least 6 feet. If the guard is within 15 inches but not within 4 inches of the belt or pulley it shall extend from the floor or platform level to a height of at least 5 feet except in each case as follows:

(a) If any part of a pulley is more than 5 feet but less than 7 feet above the floor or platform level the guard shall extend to the top of the pulley but need not exceed a height of 7 feet above the floor or platform level.

(b) If the top of any pulley is not more than 5 feet above the floor, the guard need not extend above a point midway between the top of the pulley and a height of 5 feet, provided that in no case shall it extend less than 42 inches above the floor unless it covers the top as well as all sides

of the belt and pulley, in which case there shall be no requirement as to height.

(c) If it is an overhead belt, the guard may be a basket or box, suspended from above and extending across the bottom of the pulley and all around the pulley to a height of 6 feet except where the top of the pulley exceeds such height when the guard shall extend to the top of the pulley but need not exceed 7 feet.

(3) Where no pulley hazard is involved, a standard railing (see Order B-1) placed not less than 15 inches or more than 20 inches from the belt, measured horizontally from the top of the railing, shall be considered a sufficient guard.

Note: The railing may be placed more than 20 inches from the lower run of an inclined belt if this is necessary to comply with the requirements of subsection (4) following.

(4) If the belt is inclined, the height of the guard or distance of the guard or railing from the belt shall be such that the vertical clearance between the floor and the lower run of the belt at any point outside of the guard or railing, shall not be less than 6 feet, 6 inches.

Horizontal Belts

(5) Where both runs of the belt are within 7 feet of the floor or platform level, the guard shall extend at least 15 inches above the upper run or to a height of 7 feet above the floor. In no case shall the guard extend less than 42 inches above the floor, however, except that if it covers the top as well as all sides of the belt and pulley, there shall be no requirement as to height.

(6) Where the upper run of the belt is more than 7 feet above floor or platform level and the lower run is within 7 feet of the floor, the pulleys shall be guarded on sides and outer face to a height of 7 feet above floor or platform level, and the belt guard between the two pulleys shall extend at least 15 inches above the lower run, but need not exceed a maximum of 7 feet and shall be a minimum of 42 inches above floor or platform level unless completely enclosed. Unless the guards extend across the inner face of each pulley to a height of seven feet, the guard for the lower run of the belt shall be carried to the same height as the pulley guards at all points within 15 inches horizontally from the inner face of either pulley.

(7) Where pulleys are so located and of such dimensions as to permit passage between the upper and lower runs of the belt, the space between the pulleys shall be completely barred or shall be provided with a passageway substantially guarded on sides and top and bottom.

Cone Pulleys and Belts

(8) (a) Cone pulley belts more than 2½ inches in width shall be equipped with mechanical belt shifters and all cone pulley belts shall be guarded to a point 5 inches above nipping point of belt and pulley and not less than 5 feet 6 inches from floor or platform where any part of the lower cone is less than three feet above floor

or platform level.

(b) Where both upper and lower cones are within 7 feet of floor or platform level, as for example on some vertical drill presses and other machines and for which conditions are such that mechanical belt shifters are not required and none furnished, the belt and cone pulleys shall be guarded as specified in paragraph 2-(a) of this order, with a hinged self closing section to permit shifting.

(c) All belts regardless of width shall be provided with belt shifters when joined together with metallic, or other form of fastener which by construction or wear will constitute an accident hazard.

General Interpretations

(9) An oiling runway used for the sole purpose of oiling or repairing transmission equipment shall not be classed as a platform or working level in connection with this order.

(10) Where belts are so located with reference to other equipment or to parts of buildings that they are guarded just as effectively as would be by standard guards as herein prescribed, no further guards shall be required.

(11) Where belts and other transmission apparatus are located in locked enclosure not used for manufacturing or storage purposes, and are inaccessible except when the machinery is not in motion, such locked enclosures will be accepted in lieu of other guarding.

(12) Belts which are within 18 inches horizontally from the vertical plane of the edges of any balcony or working platform (other than oiling runways) shall be subject to the same requirements as if they were directly over such balconies or platforms.

Note: (a) See Order B for requirements as to construction of guards, enclosures or casings.

Note: (b) The following illustrations and descriptive matter are intended to be helpful in meeting the requirements for the guarding of belts and pulleys. Each illustration is given the same number as the order to which it refers.

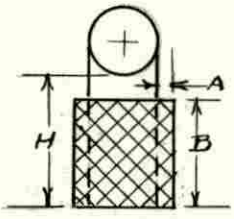


Fig. 1-(2)

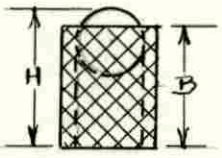


Fig. 1-(2)-(a)

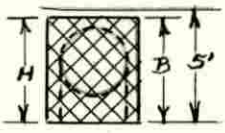


Fig. 1-(2)-(b)

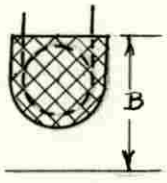


Fig. 1-(2)-(c)

Fig. 1-(2). Where H is more than 7 feet and A is 4 inches or less, B shall be at least 6 feet. If A is within 15 inches but more than 4 inches, B shall be not less than 5 feet.

Fig. 1-(2)--(a). Where H is more than 5 feet but less than 7 feet, B shall extend to the top of pulley but need not exceed 7 feet.

Fig. 1-(2)--(b). If H does not exceed 5 feet then B shall be such

that the top of guard is midway between the top of pulley and 5 feet, but B in no case to be less than 42 inches unless top as well as sides is covered, in which case there is no restriction as to height.

Fig. 1-(2)--(c). B to extend to a height of 6 feet except if the top of the pulley is more than 6 feet, B shall extend to the top of the pulley but need not exceed 7 feet.

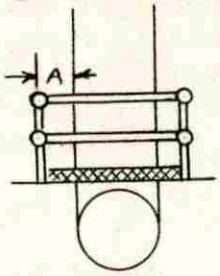


Fig. 1-(3)

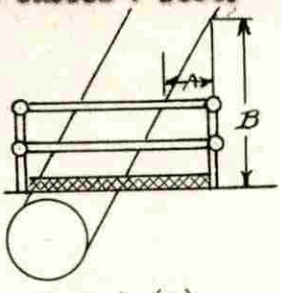


Fig. 1-(4)

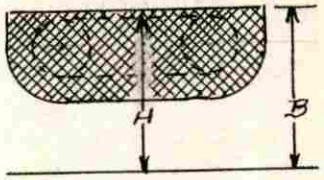


Fig. 1-(5)

Fig. 1-(3) and Fig. 1-(4) normally A to be between 15 inches and 20 inches but may exceed 20 inches in order to secure a distance of 6 feet, 6 inches for B.

Fig. 1-(5) Where H does not exceed 7 feet. B to equal H plus 15 inches, but in no case need the sum of H plus 15 inches exceed 7 feet or shall it be less than 42 inches unless entirely enclosed.

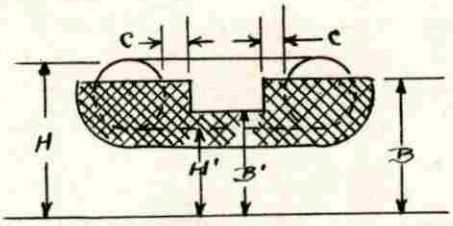


Fig. 1-(6)

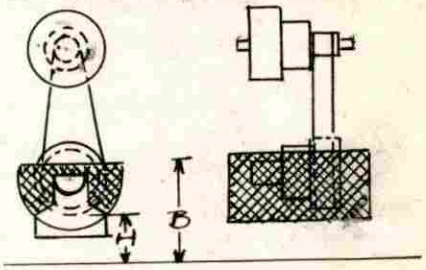


Fig. 1-(8)

Fig. 1-(6) H exceeds 7 feet and H' less than 7 feet. B to equal 7 feet. B' to equal H' plus 15 inches but in no case need B' exceed 7 feet. If inner faces of pulleys are not enclosed C to equal 15 inches.

Fig. 1-(8) Where H is less than 3 feet, B shall be such a height that it will be 3 inches above nipping point of belt and pulley and in no case less than 3 feet 6 inches.

Order 2--Pulleys and Sprockets.

Every pulley without a belt and every sprocket without a chain, exposed to contact shall be guarded in accordance with the requirements of Order B-2.

Order 3--Machine Control

Every machine shall be equipped with a loose pulley, clutch, or other adequate means readily accessible for the purpose of stopping

the machine quickly.
Machines operated from a number of different places shall be provided with readily accessible means for shutting off the power.

Order 4--Belt Shifters.
(a) Every set of tight and loose pulleys shall be equipped with a permanent belt shifter so located as to be within easy reach of the operator. The belt shifter shall be so constructed as to make it impossible for the belt to creep from the loose pulley to the tight pulley.
(b) Every belt shifter shall be equipped with an interlocking device which will prevent accidental shifting.
(c) Where overhead belt shifters are not located directly over a machine or bench, the handles shall be cut off 6 feet 6 inches above floor level.

Order 5--Pulleys--Location on Shafting.
(a) Every pulley near a shaft hanger, shaft bearing, or other fixed object shall be placed so as to allow a side clearance at least ½ inch greater than the width of the belt between the pulley and the nearest part of such shaft hanger, shaft bearing or other fixed object or a guard shall be placed adjacent to the pulley to prevent the belt from running off on the side next to the shaft hanger, shaft bearing, or other fixed object.
(b) Where pulleys must be closer together on the shaft than the width of the wider belt plus ½ inch, the pulleys shall be guarded so that the belt on either pulley cannot run off between the pulleys.

Order 6--Clutches.
(a) Every clutch exposed to contact shall be covered or enclosed in accordance with the requirements of Order B-2.
(b) Every clutch shall be equipped with a device which will prevent accidental starting.

Order 7--Swinging Doors--Windows.
Every door swinging both ways in a stairway or in a general passageway shall be equipped with a window. The windows shall be kept free from dust or other obstruction to the vision. One window shall be provided for each section of double swinging doors. Adequate artificial light shall be provided on each side of every such door and shall be used whenever the natural light is not equal to the requirements of the Industrial Lighting Code (Order 2112). The area of the window shall not be less than 200 square inches. Guards shall be placed over the window to protect the glass from being broken by protruding parts on trucks, etc.

Order 8--Abrasive Wheels, Hoods and Guards.
(a) Every abrasive wheel used for grinding purposes shall be equipped with a hood connected to an exhaust system or water system.
Exception: Wheels which are in general use by employes in

common to grind tools or do other momentary operations, portable wheels and wheels used for saw gumming.

(b) Every stationary abrasive wheel and those portables used in stationary positions shall be equipped with a guard of the hood type strong enough to withstand the shock of a bursting wheel. This guard shall be adjusted to the wear of the wheel and the maximum angular exposure shall not be more than 90 degrees or one-fourth of the periphery. This exposure shall begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle. The arbor end shall be effectively guarded.

(c) Where work rests are necessary they shall be rigid in construction and shall be kept adjusted close to the wheel with a maximum distance of 1/8 inch to prevent the work from being caught between the wheel and rest; shall be securely clamped after each adjustment, and the working surface shall be kept in good condition.

(d) Abrasive wheels shall not be run at a greater peripheral speed than is recommended by the wheel manufacturers.

Note: By abrasive wheels are meant only wheels of mineral composition, not including grind stone, metal, wooden, leather, or cloth wheels with abrasive surfaces.

(e) Guards shall be used on every portable wheel where the operation and the nature of the work will permit.

(f) Swing frame grinders. The maximum exposure of the wheel periphery or circumference for retaining hoods on swing frame grinding machines shall not exceed 180 degrees and the top half of the wheel shall be protected at all times.

Exception: Sections (b), (c) and (e) of this order shall not apply on wheels used for internal grinding, nor to wheels 3 inches or less in diameter running at a peripheral speed not exceeding 3,000 feet per minute.

Note: For detailed specifications of hoods that will comply with these requirements see Bulletin No. 527 issued by the Bureau of Labor Statistics of the U.S. Department of Labor, Washington, D.C.

Order 9--Flywheels.

Every flywheel exposed to contact within six feet of the floor or working platform shall be guarded in the same manner as belts, etc. in Order 1.

Flywheels located in engine room may be guarded by standard guard rails and toeboards, placed not less than 18 inches nor more than 20 inches away from the rim of the wheel.

Order 10--Friction Drives.

The faces of every friction drive together with all openings and projections exposed to contact, shall be covered or enclosed in accordance with the requirements of Order B-2.

Order 11--Gears.

All gears shall be solidly enclosed, except that gears without

spokes or holes in web may be guarded by a band guard with flanges extending beyond the root of the teeth.

Guards may be made in accordance with the specifications of Order B-2 provided they are placed not less than 2 inches from any moving part.

Order 12--Keys and Keyseats.

(a) Every projecting key in revolving shafting where exposed to contact, shall be cut off or enclosed.

(b) Every keyseat in revolving shafting, where exposed to contact, shall be filled or enclosed.

Exceptions: Keys and keyseats in shafting of machines where it is not possible to guard or fill the keyseats without interfering with the operation of the machinery.

Order 13--Ladders.

A ladder is a framework consisting of two or more approximately parallel stringers to which are substantially attached horizontal cleats or rungs uniformly spaced, and used for ascending to or descending from elevated places.

(a) General Requirements.

All ladders shall be substantially built and maintained in a safe condition. Stringers and cleats on all wood ladders shall be of sound, straight grained spruce or equal. Rungs shall be of hickory, oak or white ash or equal. Rungs or cleats shall be secured to stringers in such a manner as to insure maximum strength and rigidity of the ladder.

Rungs or cleats shall be of uniform size and spacing, but in no case spaced more than 14 inches center to center.

No wood ladder shall be painted with an opaque pigment. If preservation is needed, a transparent oil or varnish shall be used.

All metal parts or fittings of ladders shall be of mild steel, malleable cast iron, wrought iron, or their equivalent.

(b) Fixed Ladders.

1. Every fixed ladder shall be installed with a minimum clearance of 6 inches from back of the rung to the nearest permanent object.

2. A cage or basket guard shall be placed on permanent fixed ladders of 20 feet or more in length.

Note 1: It is not intended that this requirement shall apply to ladders used exclusively for fire purposes.

Note 2: It is intended that this requirement shall apply to fixed ladders making an angle of more than 75 degrees with the horizontal.

Cages shall extend from top of ladder to a point 7 feet above the base with bottom flared 4 inches, or portion of cage opposite ladder shall be carried to the base.

Cages shall be substantially built and securely fastened to the ladder. The inside shall be clear of projections.

Cage shall extend not less than 20 inches nor more than 24 inches from face of ladder. Cage should be no less than 24 inches in width.

(c) Portable Ladders.

All portable ladders shall be equipped with some effective means so as to prevent slipping. When points are used they shall be of hardened steel and kept sharp.

(d) Step Ladders.

A step ladder is a ladder having rungs or flat treads and so constructed as to be self-supporting and shall be built in accordance with the general requirements of Item (a) of this order.

An attendant to hold ladder shall be furnished in all cases where portable step ladders are more than 10 feet in height.

The use of portable step ladders more than 20 feet in height is not permitted.

A spreader with an automatic locking device to hold the front and back securely in the open position shall be a component part of each portable step ladder.

All stationary step ladders shall be equipped with handrails 30 to 36 inches high on both sides measured vertically from the nose to the tread.

Note: For detailed specifications of ladders see Bulletin No. A14-1935, published by the American Standards Association, 29 West Thirty-ninth Street, New York City.

Order 14--Passageways and Working Spaces.

(a) Adequate passageways and gangways shall be provided. The floors of all such passageways and gangways shall be reasonably even, kept in good repair, and as far as the nature of the industry will permit, kept free from obstructions or substances over which or on which persons may stumble, slip or fall.

(b) Adequate working spaces shall be provided for the safe operation of every machine and such working space shall not be obstructed either by storing or piling material, or other objects.

(c) The floor or ground surrounding machines shall be reasonably even, kept in good repair, free from obstruction over which persons may trip, and means provided to insure secure footing insofar as the nature of the work will permit.

Order 15--Elevated Walks, Platforms and Runways.

(a) Every permanent elevated platform shall be provided with either a stairway, the steps of which shall have a uniform rise of not more than 8 inches and a uniform tread of not less than 9 inches and equipped with handrails and maintained in accordance with Order 20, or a stationary ladder or stationary step ladder in accordance with Order 13. Where a stationary ladder is used the side rails shall extend at least 42 inches above the platform.

Exception: This order does not include platforms supporting single units of equipment which receive no attention other than oiling or repairs, nor does it include platforms used exclusively in connection with such equipment as steam traps and sprinkler valves. However, it is recommended that permanent ladders or stairways be used wherever possible.

Note: This exception is not intended to include water tanks.

(b) Every elevated walk, runway or platform shall be substantially constructed and shall be equipped with standard guard rails and toeboards.

Exception: Guard rails and toeboards will not be required on loading or unloading sides of shipping platforms with the exception of lumber yard shed platforms where handrails only will be required. However, it is recommended that protection be furnished in all cases wherever possible.

(c) Every platform located on an engine or other large machine for the use of operators or others shall have a non-slip surface and shall be equipped with guard rails and toeboards.

Order 17--Set Screws.

Every set screw in moving parts where exposed to contact shall be set in a counterbore, protected by a solid collar, or be of the headless type so that no part of the set screw will project above the surface.

Order 18--Shafting.

(a) All exposed parts of transmission shafting shall be protected by a stationary casing enclosing shafting completely. Horizontal shafting may be guarded by a trough enclosing sides and top or sides and bottom of shafting as location requires.

Exception: Shafting more than seven feet above the floor, oiling runway, or other working level, need not be guarded provided the shafting ceases to revolve before any work of a character which would expose any person to contact with such a shaft, is permitted.

(b) Shafting under bench machines shall be enclosed by s stationare casing or by a trough at sides and top, or sides and bottom, as location requires. The sides of the trough shall come within at least 6 inches of the underside of the table, or if shafting is located near floor, within 6 inches of floor. In every case the sides of trough shall extend at least 2 inches below or above the shafting as the case may be. For specifications of material see Order B-2.

(c) Revolving shafting and spindles forming part of and integral with individual machines where such part creates a hazard shall be enclosed or covered.

Order 19--Maintenance of Machine Tools and Machinery.

(a) Machine tools, power driven machinery and all parts of such machinery shall be maintained in good working order and safe condition.

(b) Hand tools furnished by the employer shall be issued in good condition.

Note: It is recommended that the employer adopt a rule requiring employes to report defective tools.

Order 20--Stairways--Handrails and Maintenance.

(a) Every stairway or steps of four or more risers shall be equipped with a substantial smooth handrail from 30 inches to 36 inches high measured vertically from the nose of the tread and placed on the left hand side as one mounts the stairs, or on the open side, if any. Stairways or steps 5 feet or more in width, or open on both sides shall have a handrail on each side. (See Building Code Order 5116).

(b) Every stairway shall be maintained in good repair, free from protruding bolts, screws, nails, etc., unnecessary dirt or slippery condition and treads shall be renewed when the surface shows wear to the extent of one-half inch or more.

Stairways shall not be used for storage purposes, and any necessary equipment shall be so located that its presence or use will not obstruct or interfere with free passage.

(c) All metal treads shall have a rough or non-slip surface.

Order 21--Crank Shafts and Eccentrics.

(a) The crank shaft and crank or crank disc on every engine and every similar part on other machinery, where exposed to contact, shall be guarded in accordance with the requirements of Order B.

(b) The eccentric of every engine and every similar part on other machines, where such parts create a shearing hazard and where exposed to contact shall be guarded.

Order 23--Metal Planers and Other Machines of Similar Construction Ways Guarded.

On metal planers and other machines of similar construction, parts of which have a reciprocating motion, the spaces between the ways where exposed to contact shall be covered to eliminate the shearing hazard.

Order 24--Oiling Devices.

All machines lubricated while in motion and having lubricating devices so located as to make them dangerous to reach the same while the machines are in motion, shall be equipped with an automatic oiling device or some other means to protect the oiler.

Order 25--Projecting Parts on Shafts.

Every projecting part on a revolving shaft such as a collar, clamp, pin, coupling, oiling device, etc., where exposed to contact, shall be enclosed or covered.

Note: If machinery is oiled while in motion, then projecting or dangerous moving parts are considered as exposed to contact.

Order 26--Means to Disconnect Power.

In each room of a place of employment, where machinery is used, means shall be provided by which the power can be quickly disconnected.

Note: This order includes conveyor systems.

Order 27--Drop Hammers.

(a) Every drop hammer, the operation of which requires the hands to be placed between the dies, shall be provided with a positive stop that will prevent the descent of the hammer until the operator's hands are withdrawn.

(b) A shield or screen shall be provided for every drop hammer except where guarded by location when the operation is such that sparks or scales are liable to be thrown off.

(c) On every board drop hammer a substantial guard shall be provided around the board above the roll to prevent the board falling in case the board breaks or comes loose from the ram.

Order 29--Machines for Shearing or Cutting--Knives Guarded.

The knife or knives of each machine used for shearing or cutting material of any kind shall be guarded in a manner that will prevent the operator's hands from coming in contact with the knife or knives.

Note: Machines that are set in motion by a two hand device will be considered as complying with this order provided the design and construction of the two hand device is such that the operator cannot place his hands in the path of the descending knife after tripping the machine.

Order 30--Presses--Guards.

The dies of every press used for such work as punching, blanking, shearing, stamping, forming, embossing, drawing, creasing, etc. on material of any kind shall be protected by means of the following:

a--Complete enclosure, or

b--Full automatic feed, or

c--Semi-automatic feed with plunger enclosure or limited opening (3/8") between dies, or

d--Limited opening (3/8") between dies.

In case a,b,c or d cannot be applied, then a device to prevent the hands of the operator from coming in contact with the dies shall be installed, such as

e--Two hand tripping device.

f--Sweep or gate guard, the action of which shall be positive with each descending stroke of the ram.

g--A device that will be positive and withdraw both hands of the operator with each descending stroke of the ram.

h--Special hand tools.

Note: Bulletin No. 430 "Safety Code for Power Presses and Foot and Hand Presses," published by the Bureau of Labor Statistics, U.S. Department of Labor, Washington, D.C., will be helpful in complying with this order.

Order 31--Hand Feed Platen Presses.

Every hand feed platen press shall be guarded by means of an automatic device that will prevent platen from closing before operator's hands are removed from between the platen and the bed or by means of

a guard that will force the hands from between the platen and bed.
The front of the press shall be guarded by an apron enclosure to prevent injury by the bottom of the platen or the lock below the feed table.

Order 32--Locks for Tripping Devices.
Every machine set in motion by a tripping device shall be guarded against accidental tripping by means of a positive stop arranged to prevent operation until holding catch is manually released or by means of a guard over tripping lever or pedal which shall be so equipped that when machine is not in use, or while being adjusted or repaired, the lever or pedal can be locked, or blocked.

Order 33--Revolving Stock.
All revolving stock projecting from machines shall be guarded by pipe enclosure or other means to prevent contact with the stock.
Note: It is desirable to reduce to the minimum the noise incident to the operation of these machines, especially where there are a number placed close to each other.

Order 34--Fans.
The blades of every fan when exposed to contact shall be guarded in accordance with order B-2.
Note: This order also applies to the ordinary office fan.

Order 35--Revolving Drums and Cylinders.
(a) Revolving barrels, drums or cylinders, such as cleaners or churns, where exposed to contact, shall be guarded by an enclosure or standard guard rail in accordance with the specifications given in Order B.
(b) Tanning drums and rattlers where exposed to contact shall be guarded by an enclosure built in accordance with the specifications of B-2 to a height of 6 feet unless the axis of the drum or rattler is less than 6 feet from the floor, in which case the guard shall extend to a height half way between the axis and the top but not more than 6 feet or less than 42 inches.
(c) Every drum or other revolving container, which must be loaded or unloaded shall be equipped with a brake or lock which will enable the operator to lock the drum while loading or unloading it.
This does not include extractors which are covered in Order 230.

Order 36--Counterweights and Tension Weights.
(a) Every counterweight where exposed to contact shall be enclosed or equipped with a safety chain to prevent the weight from falling.
(b) Every tension weight exposed to contact shall be enclosed or securely fastened to the tension bar.

Order 37--Overhead Trolleys and Monorail Cranes.
Every overhead trolley and every monorail crane shall be construct-

ed so as to prevent its leaving the track at any point.

Order 38--Valves, Access To.

Where a valve in daily use is located higher than ten feet above the floor, a platform equipped as required in Order 15 (a) shall be provided.

Exception: Valves which are operated from the floor by means of chains or other such long range control devices.

Order 39--Spaces Between Fixed Objects and Machines.

On every machine where a moving part at any time leaves a space of less than 18 inches between it and any fixed object not a part of the machine, or between it and the moving part of any other machine, such space, when not guarded by location shall be enclosed in accordance with Order B.

Order 40--Cranes.

(a) The truck wheels of every overhead traveling crane except of the monorail type shall be equipped with suitable guards in front of the wheels extending down below the level of the top of the rail and so designed as to clear the track of any objects.

(b) Safe means shall be provided for lubrication of the crane trucks.

(c) 1-The bridge and trolley of electric overhead traveling cranes shall be provided with substantial and effective buffers, preferably of the air cushion, spring or similar type or curved rails with the radius larger than the wheels shall be employed.

2-Where two or more cranes are operating on the same runway, substantial and effective buffers shall be provided to prevent injury in case of cranes coming together.

(d) 1-Each crane hoist motor shall be equipped with a magnetic brake so arranged that it will be applied when the power is cut off from the brake magnet. This brake shall have sufficient torque to sustain at least one and one-half times the rated load.

Note: On cranes where a combination mechanical load lowering brake and a magnet brake on motor shafts are employed, the two brakes together should meet this requirement, but need not do so individually.

2-Cranes that have a cab on the trolley shall be equipped with brakes for the trolley motion.

3-The bridge travel on each crane shall be equipped with a brake.

4-The brakes specified in d-2 and d-3 of this order shall be capable of producing a torque sufficient to retard at the rate of not less than one foot per second--per second when manually operated, this rate of retardation shall not require a force on the brake lever in excess of 100 pounds.

Note: A maximum limit for retardation cannot be set as a general rule, but in no case should it be such as to introduce hazardous conditions when consideration is given to the character

of the service and the characteristics of the equipment.

Order 41--Crane Footwalks.

(a) Every overhead traveling crane that is propelled by other means than hand power shall be equipped with a footwalk extending the entire length of the bridge on the shaft side. The opposite side shall be equipped with a footwalk twice the length of the trolley except where a fixed platform is provided and is available at the end of the runway. The width of the footwalk shall not be less than 30 inches. Standard guard rail and toeboards shall be provided. Any opening or separation between the bridge and footwalk or in the floor of the footwalk shall not exceed ½ inch.

(b) When footwalks are required on both sides of the bridge, provision shall be made for passage between them at the end of the bridge, or by means of a platform in the building adjacent to and outside of the crane runway.

Exception to (a) and (b): No footwalk with less than 4 feet overhead clearance at all points shall be permitted on an overhead traveling crane. In such case a permanent platform at the ends of the runway or a temporary scaffold or staging shall be provided for maintenance or repairs.

Order 42--Electrically Operated Traveling Cranes--Switches in Cages.

A main line switch shall be installed in the cage of every electrically operated traveling crane and so placed as to be readily accessible to the operator. This switch shall be completely enclosed, externally operated and provided with padlocking facilities so that the operator or others working on the crane will be protected.

Switches shall be locked in the open position against unauthorized use.

See also Order 1312.02 (e), 1330.06 and Section 133.0 of Wisconsin State Electrical Code.)

Order 43--Cranes--Stairways.

Every overhead traveling crane operated from a cage shall be provided with a stairway or permanent ladder between the cage and the crane footwalk, and between the cage and the floor.

Order 44--Crane Cages--Enclosures.

(a) The cage floor of every overhead traveling crane shall be solid except that grating not exceeding ½ inch wide may be provided where necessary for vision.

(b) The sides of the cage of every overhead traveling crane shall be enclosed in the following manner:

1--(a) Solid to a height of 42 inches, or,
(b) Not less than No. 10 wire screen with mesh not greater than 3 inches to a height of 42 inches with toeboard, or,
2-- Standard guard rail and toeboard.

Order 45--Cables, Ropes and Chains--Safe Loads.

(a) The maximum safe working load for all hoisting cables shall not exceed 1/7 of the breaking load as determined by the cable manufacturers.

A cable is considered unsafe and shall be renewed when through broken wires, wear, rust, undue strain, or other cause the strength of the cable becomes reduced 25 per cent.

Note a: Cables will be considered unsafe when upon inspection in a length equal to 8 diameters of the cable 10 per cent or more of the total number of wires are broken.

Note b: Cables should be lubricated and carefully inspected at frequent intervals. Proper lubrication adds much to their durability.

(b) Ropes when used for hoisting shall not be subjected to greater working loads than those recommended by the rope manufacturers.

Ropes shall be frequently inspected and renewed when inspection reveals defective and unsafe conditions.

Note: Serious accidents have resulted from allowing acid to come in contact with hoisting rope. This may occur when swinging scaffolds are used to clean building walls with acid solutions. Casual inspection will not reveal the condition of the rope after such exposure.

(c) Chains when used for hoisting shall not be subjected to greater working loads than those recommended by the chain manufacturers.

Chains shall be frequently inspected and tested. They shall be renewed when defective and unsafe conditions are revealed.

Order 46--Eye Protection.

(a) Where persons are doing work whereby any substance is thrown off which may injure the eyes, suitable individual goggles shall be provided. An effective device may be used in lieu of goggles in connection with occasional work of short duration such as the sharpening of tools when done by the employes who use such tools.

(b) Where persons are doing work such as oxy-acetylene or electric welding or any other work where intense heat or light rays may injure the eyes, suitable goggles designed to absorb the harmful rays shall be provided.

Note: A suitable goggle shall be such as will protect the eyes against the injuries of foreign objects, harmful rays, heat, fumes or vapors and will not materially impair the natural or corrective vision of the wearer, and shall be adapted to the individual facial characteristics.

Order 47--Scaffolds for All Other Work Not Within the Scope of the General Orders on Safety in Construction.

(a) Where employes are required or permitted to work in exposed or elevated places, scaffolds shall be provided unless the work to be performed is of such a nature and extent that ladders can be used with a reasonable degree of safety.

(b) Every scaffold, including chair scaffolds and swinging scaffolds, shall be built to sustain a load of at least three times the weight of men and material likely to be placed upon the scaffold at any one time.

(c) Every scaffold, except swinging and chair scaffolds, shall be provided with a ladder or other adequate means of ascending to or descending from it.

(d) Every scaffold shall be equipped with standard guard rails and toeboards.

Exception: Scaffolds for work, the nature or surroundings of which make either or both guard rails and toeboards unnecessary for reasonable safety.

(e) Every swinging scaffold, except chair scaffolds, shall be equipped for each workman on the scaffold, with a life line with fixed end securely fastened independent of the scaffold and with the free end extending to the ground.

(f) Every chair scaffold shall be equipped with a safety belt.

Note a: The failure of a scaffold or any part of a scaffold will be considered presumptive evidence of faulty construction or defective material.

Note b: Several different types of scaffolds that conform to this order are shown in the General Orders on Safety in Construction.

Order 48--Corner Staying Machines.

The pressure head of every machine, such as is used to fasten the corners of cardboard boxes shall be guarded by means of a positive stop device, that will prevent the dies from closing until the operator's hands are removed from between the dies.

Order 49--Machinery with Revolving Cylinders in Leather Industries.

Machines with revolving cylinders, to which cylinder knives, blades, brushes, sand paper, etc. are attached used for the purpose of surfacing hides, and leather, such as fleshing machines, setting out machines, shaving machines and brush machines shall be guarded.

Note: In guarding shaving machine cylinders, a band guard shall extend over the ends of the cylinder blades and a rod (finger grip) guard shall be placed above the opening of machine.

Order 50--Jacks in Leather Industries.

Jacks used for glazing, rolling, pebbling, and setting out shall be guarded.

Exception: Sole leather rolling jacks are not included in this order.

Order 51--Setting Out Machines.

All setting out leather machines with horizontal traveling tables shall be so guarded that the operator will not be drawn into the machine.

Note: A tripping bar across the feeding sides of the machine

and so arranged that, upon being tripped, it will shut off the power and set a brake, should give adequate protection.

Order 52--Rolls, Wheels and Brushes Guarded.

(a) Rolls, wheels, brushes and other revolving parts of machines not otherwise specifically covered elsewhere in these orders, when revolving in such a way with respect to other parts as to create a hazard shall be equipped with a device designed to prevent injury.

Note: The most effective method of accomplishing this is by means of an enclosure.

(b) Vertical feed rolls shall be guarded on the sides and in front by an enclosure extending to within one-half inch of the plane formed by the working edge of each roll.

Horizontal feed rolls shall be enclosed by a cover over the top, front and open sides. The lower edge of the cover shall come down to a point one-half inch above the plane level with the bottom edge of the roll.

(c) In the case of rolls where it is impracticable to install fixed guards such as in rubber mills, a positive quick stopping device shall be provided.

Order 53--Excavations.

(a) All excavations when so located that persons may accidentally fall into them shall be guarded by adequate barriers not less than 36 inches in height and in addition shall be marked with torches or red lights at night.

(b) All excavations, in which persons are required to work, shall be sloped or shored so as to reasonably protect employes and frequenters from the hazard of cave-ins.

Note a: On account of many conditions that may arise in connection with the protection of excavations, such as size and depth, nature of soil and weather, no detailed method of compliance with this order is given here, and employers should see to it that each job is protected as circumstances require.

Note b: The only place where this order will apply is for excavations other than trenches.

For specifications for trench shoring see Order 610, General Orders on Tunnel, Caisson and Trench Construction.

Order 54--Vats, Tanks and Hoppers.

(a) Open tops of vats, tanks and hoppers, the tops of which are less than 36 inches above the floor or platform level, shall be covered or protected by railings in accordance with Order B-1.

(b) Before any person is permitted to enter any tank, vat or hopper used for the handling or storage of liquids, compounds or other contents, the chemical elements of which cause the formation of injurious gases or fumes, all liquid contents shall be drained off, and the drain outlet left wide open. In the case of closed tanks, vats and hoppers and where necessary in the case of open tanks, vats and hoppers as an additional precaution at least one

attendant for each person in the vat, tank or hopper shall be stationed continuously at the opening and a rope shall be furnished for each such person, one end of which shall be attached to the person in the vat, tank, or hopper, the other end being within the control of the attendant.

(c) Before repairing tanks or containers used for explosive liquids or substances, care shall be taken to completely exhaust all gases and to remove sediment.

(d) Storage vats, tanks and hoppers containing materials liable to jam or form a crust shall be provided with a substantial platform surrounding the top edge or built over the top to enable the operator to manipulate the pricker bar with safety or a drop weight device shall be provided to be manipulated from the outside of the tank, vat or hopper.

Note: See Orders 2007, 2013 General Orders on Dusts, Fumes, Vapors and Gases.

Order 55--Pits, Openings in Floors, etc.

Pits, manholes and openings in floors, platforms and sidewalks shall be guarded in accordance with the requirements of Order B-1. If a trap door is used the door and hinges shall be flush with the floor and the door shall have a rough and non-slip surface.

Order 56--Window Cleaning.

(a) Windows in public buildings and places of employment, the tops of which are more than 20 feet above the ground floor, flat roof, balcony or permanent platform shall be equipped with approved means to protect the window cleaners; such means shall consist of

1. A safety belt for each window cleaner, which belt shall be fastened at each end to a permanent device that shall be firmly attached to the window frame, or to the building proper; or

2. A substantial portable platform that is projected through the window or supported from the ground, floor, roof or platform level, for the window cleaner to stand upon and that is equipped with an approved handrail and toeboard; or

3. A substantial swinging scaffold equipped with standard handrails, toeboards and life line; or

4. A substantial chair scaffold equipped with a safety belt; or

5. Other equally efficient devices.

(b) For cleaning the insides of skylights (the highest parts of which are more than 20 feet above the ground, floor, balcony or permanent platform and to which access cannot be gained by any of the means described in (a), scaffold as specified in Order No. 47 shall be provided.

(c) All equipment including building parts and attachments, used in connection with window cleaning shall be maintained in safe condition while in use and shall be competently inspected by the employer or his agent at least once each month while in use.

If such equipment has not been in use for thirty days or more, then careful inspection shall be made before using.

Order 57--Doorways Near Railway Tracks and Driveways.

When a doorway or corner of a building is located near a railway, trolley track or driveway, so that a person is liable to suddenly and unexpectedly walk out onto the track in front of any railway rolling stock or vehicle, an efficient guard shall be installed with a warning sign.

Note: Efficient guards may consist of one of the following:

1. A swinging barrier located at the door opening or corner extending across the doorway or from the corner.
2. A deflecting barrier situated outside the building parallel to the opening and approximately 36 inches away from it.
3. A deflecting barrier situated at the corner parallel to the tracks or driveway and extending for a distance of not less than six feet outward from the corner.

Order 58--Elevated Walks, Runways or Platforms.

Elevated walks, runways or platforms shall be provided where ladders are not used for oiling overhead shafting or machinery, or doing other overhead routine work. Such walks, runways or platforms shall be constructed in accordance with the provisions of Order 15.

Order 59--Trestles and Walks.

The parts of every trestle, on which cars run, that are used for walkways, shall be equipped on the outer edge with a walkway so located as to give safe clearance from cars. Such walkways shall be equipped with standard guard rails, and toeboards, except such parts as are used for loading and unloading purposes.

If the walkway is inclined it shall be equipped with cleats.

Where a trestle crosses a driveway or passageway, the floor of trestle over such points shall be solid.

Order 60--Flyers on Spinners.

Spinners, such as are used in twine mills, when the flyers are exposed to contact, shall be equipped with guards so adjusted as to completely cover the flyers and so locked that they cannot be opened when the flyers are in motion.

Order 61--Calendars--Doctors.

On all machine calendars used in paper mills, except super-calendars, each roll must be equipped with an efficient doctor.

Order 62--Calendars--Feeding Belts.

On all machine calendars, except super-calendars, where the paper is taken over the top roll to be fed into the first nip, a feeding belt or other efficient device must be provided to conduct the paper into the first nip and thus make it unnecessary for the operator to use his hands in this dangerous place.

Order 63--Driers--Doctors.

On all paper machines with drier felts, each lower drier must be equipped with an efficient doctor.

Note: It has been found from experience that doctor blades made of well seasoned straight grained maple are equally as efficient as blades made from iron or bronze, and are cheaper. Wood blades will not cut the face of the driers.

Order 64--Drum Winders--Guards.

On all drum winders where the drum and paper roll run in on the operating side, the point of contact must be guarded.

Order 65--Winding Reels--Space Between.

The winding reels in paper mills used with the paper machine, where the rolls of paper run in, must be guarded or the reels must be so constructed that it is impossible to have less space than 8 inches between the reels of paper when they reach the maximum size.

Note: In order to limit the space between the reels a permanent stop may be placed below the bottom reel and above the top reel, which will limit the size of the reels.

Order 66--Barkers and Chippers--Speed Governors.

All barkers and chippers must be so equipped that the speed is maintained within safe limits.

Note: (a) The term "safe limits" used in the above order shall mean the maximum safe speed as prescribed by the manufacturer of the machine. The records of accidents in Wisconsin caused by explosions of discs on chippers and barkers reveal the fact that practically all of them were caused by overspeeding and would have been prevented by an efficient governor to regulate the speed.

Note: (b) All barkers and chippers should be thoroughly inspected and tested at least once each week to detect cracks and flaws in the discs.

Order 100--Car Stakes and Binders.

On logging roads operated by lumbermen, the stakes or binders used on logging cars to hold the load of logs in place when being transported, must be so designed as to make it possible for the operator, when standing in a safe position away from the front of the car, to loosen or disengage such stakes or binders.

Order 105--Concrete Mixers, Guards for Power Charging Skips.

Every concrete mixer having a mixing capacity or 15 or more cubic feet and equipped with a power charging skip, shall have both sides and end of the working space for the skip guarded in such a manner as to prevent workmen from accidentally walking underneath the skip when elevated.

Order 110--Dough Mixers--Baking and Confectionery.

(a) Each dough mixer shall be provided with a cover, preferably solid, but which may have openings if it is necessary to see, or add ingredients to the batch while mixing operation is in progress. This cover, if hinged, or detachable, shall be provided with an interlock, so that it cannot be opened while the mixer is in normal operation.

(b) Each dough mixer shall be provided with an approved interlock so arranged that the machine cannot normally be operated except in the normal operating position.

(c) When necessary to move blades for unloading purposes each mixer shall be equipped with an emergency operating button or its equivalent, located not less than 6 feet from the machine and so arranged that blades will revolve only while the operator holds button or other power control in the "on" position.

Order 115--Conveyors.

(a) The nipping and shearing points of conveyors when exposed to contact shall be guarded in accordance with Order B-2

(b) The tops of screw conveyor troughs, where screw is exposed to contact, shall be kept covered. Necessary openings to which persons may step, reach or fall shall be protected by standard handrails or other suitable adequate protection.

Order 125--Man Lifts.

(a) Each man lift, such as is used in flour mills shall be equipped with a safety device so constructed and maintained that the machine will be automatically stopped when any step tread bearing a weight of 50 pounds or more reaches a height of not more than 3 feet 6 inches above the top floor or landing level.

(b) Each step tread shall be at least 10 inches wide and at least 12 inches long and shall be attached to the belt in a way to insure its remaining at right angles to the belt. The openings in the floor through which the belt and step treads pass shall be uniform in size and provide a safe clearance for a person standing on any step tread.

Handles shall be securely attached to the belt at points approximately 4 feet above and below each step tread.

(c) Standard guard rails and toeboards shall be provided around the floor openings in connection with each man lift, except such space as may be necessary for access to the step treads.

Order 130--Gas Welding and Cutting.

(a) All cylinders for compressed gases shall be of types approved by the Industrial Commission. In general, cylinders in compliance with the shipping container specifications and so marked, will be approved. Gas generators, regulators, consuming devices and other fittings for welding and cutting shall be of a type approved by the Industrial Commission.

Note: Devices listed as standard by the Underwriters' Laboratories will in general be approved.

(b) Acetylene shall not be generated or utilized at a pressure in excess of 15 pounds per square inch guage pressure. This requirement is not intended to apply to the storage of acetylene dissolved in suitable solvents in cylinders manufactured in accordance with the requirements of paragraph (a).

(c) Gases shall not be transferred from one cylinder to another.

(d) Gas shall not be used from a cylinder except through an approved pressure reducing regulator.

(e) Cylinders not provided with hand wheel valves shall have spindle keys on valve spindles or stems while cylinders are in service. Empty cylinders shall be plainly marked EMPTY and valves shall be closed.

(f) Cylinders shall be so located or protected that they will not be exposed to sparks or flames, and shall be located so they will not fall or be struck by other objects.

(g) While gas is being used in a confined space the cylinders shall be located outside of such space, and a helper shall be present at all times to attend to the cylinder valves or assist in any emergency.

(h) Fuel gas or oxygen from a cylinder shall not be used as a substitute for compressed air.

Suggestions for Cutting and Welding

(a) Welding or cutting should be done by or under the supervision of a trained operator.

(b) Every possible precaution should be taken to prevent oxygen and apparatus used in conjunction with an oxygen supply from coming into contact with oil or grease.

(c) Fuel gas and oxygen hose should be of different colors, preferably red for fuel gas and green or black for oxygen.

Note: The gas welding and cutting industry is attempting to standardize red as standard color for fuel gas and green for oxygen hose.

(d) Compressed gas cylinders should be handled carefully and never dropped. When an outfit is frequently moved for portable work, suitable hand trucks should be provided with chains or steadying devices to prevent cylinders from being knocked over while being moved or while in use.

(e) Hose should be firmly secured to the blow pipes and regulators for reducing valves before using. Cylinder valves should be opened slowly.

(f) Welding brass or bronze should be conducted in well ventilated locations.

Order 200--Jointers, Hand Feed.

(a) Every hand feed jointer with a horizontal cutting head shall be equipped with a cylindrical head the throat of which shall not be more than 7/16 inches in depth by not more than 5/8 inches wide.

Note: It is strongly recommended that no cylinder be used in which the throat exceeds 3/8 inches in depth, or ½ inch in width.

(b) Each hand feed jointer with a horizontal cutting head shall be equipped with a guard that will automatically cover the head.

(c) Every hand feed jointer with a horizontal cutting head shall be equipped with a guard which will automatically cover the section of the cutting head back of the guage.

(d) Every jointer head shall be enclosed on the under side of the jointer frame or table.

Note: Exhaust hoods when properly connected under the table are considered effective guards.

(e) Every wood jointer with a vertical cutting head or with a disc cutter head shall be equipped with an exhaust hood or other guard arranged in either case so that the revolving head or disc shall be completely enclosed except that a slot shall be provided of the proper size to accomodate the material to be jointed.

Order 202--Band Saws.

(a) Both wheels of every band saw shall be completely enclosed.

Note: The enclosure for the wheels should be arranged so that one side of each can be easily and quickly opened up or removed.

(b) The section of the saw blade on each hand feed band saw shall be enclosed on two sides and the cutting edge except that portion actually needed to make the cut.

Note: The guard for the blade above the roller guide on any vertical hand feed band saw should be so designed and attached that the guard automatically covers the blade above the roller regardless of the height at which the guide is set.

Order 203--Circular Saws.

(a) Every self feed rip saw shall be guarded and those not equipped with spreaders shall be provided with substantial anti-kick back devices and equipped with out-feed.

(b) Every hand feed circular rip saw shall be equipped with a hood type guard which will cover the section of the saw disc above the table. The hood shall automatically adjust itself to the thickness of the material being cut.

(c) Every hand feed circular rip saw shall be equipped with a spreader which shall be securely attached to the saw table, throat piece or saw frame, and which shall be of such thickness and set with such relation to the saw as to prevent the stock binding on the saw.

Note: Kickbacks usually result from one or more of the three following causes:

1. Improperly conditioned saw.
2. Improperly conditioned lumber.
3. Improperly aligned guage or fence.

(d) Every circular cut-off saw shall be guarded so that the section of the saw disc above the bench or table will be covered at all times.

(e) Every circular saw shall be enclosed under the saw frame or

table.

Note: Exhaust hoods when properly connected under the table are considered effective guards.

(f) Gang trimmers, gang slashers and equalizers shall be guarded by front and rear fences.

Order 204--Machines with Cutting Heads.

(a) Every cutting head on shapers, hand feed panel raisers and similar heads of other machines, not automatically fed shall be guarded. This can be accomplished either by an enclosure guard, or by the use of forms which shall be maintained in good condition, and in which the work shall be securely fastened and which shall be so designed and constructed as to effectively protect the operator's hands.

Note: Wherever possible it is desirable that double spindle shapers be equipped with a starting and stopping device for each spindle.

(b) Every cutting head of power feed machines such as molders, stickers, planers, matchers, tenoners, jointers, dado machines, rabbetting machines and similar heads of other machines shall be guarded. Exhaust hoods when properly constructed and attached constitute an acceptable guard for the cutting heads of these machines.

Order 205--Swing Cut-Off Saws, Automatic Return and Limit Stops.

(a) Every swing cut-off saw shall be equipped with an effective device--which shall not involve the use of any rope, cord or spring--to return the saw to the limit stop at the back of the table when released at any point of the travel.

(b) Every swing cut-off saw shall be equipped with a limit chain or other equally effective device to prevent the saw from swinging beyond the front edge of table.

Order 226--Flat Work Ironers.

All flat work ironers must be equipped with guards in front of the feed rolls to prevent the hands of operators from being drawn into the rolls. When the so-called doffer roll is used, and is propelled by other power than the ribbon or apron feed, a guard must be placed in front of this roll.

Note: It has been found from experience that the most efficient guard on flat work ironers is the automatic stop guard which disengages the power when the hand of the operator strikes the guard. The ribbon or apron feeds are not adequate safeguards as there is nothing to prevent a thoughtless or reckless operator from feeding over the apron and getting her hands dangerously close to the rolls.

Order 227--Bosom and Combination Ironers.

All bosom and combination ironers must be equipped with guards placed near enough to the rolls and the ironing board to prevent

the hands of the operator from being drawn under the rolls.

Order 228--Collar and Cuff Ironers.

All collar and cuff ironers must be equipped with guards in front of the first rolls to prevent the hands of the operator from being drawn into the rolls

Note: (a) Platforms for Body Ironers. On all one-way, single treadle, body ironers, the operator should be furnished with a platform which should be the height of the foot treadle when at the lowest point.

Note: (b) Minimum Foot Power. The proprietors and foremen of laundries should do everything in their power to educate operators of cuff, neck-band and yoke presses, to use the minimum amount of foot pressure necessary to do proper work. It has been found from careful experiments made by competent laundrymen, that 75 pounds is the maximum amount of pressure necessary to do perfect work on any of the above mentioned machines. Additional pressure is, therefore, not only a waste of the operators' energy, but a needless wear on the machinery.

Order 229--Locks on Washing Machines.

Each washing machine must be equipped with a brake which will enable the operator to lock the machine when he is filling or emptying the cylinders.

Order 230--Guards on Extractors.

Each extractor must be equipped with a safety cover so constructed that the machine cannot be started until the cover is in place and the cover cannot be opened until the machine is brought to a dead stop. The cover must be constructed of wire screening with square mesh not larger than one-half inch. This order applies also to extractors located in industries other than laundries.

Order 231--Flat Work Ironers--Rolls Guarded.

All flat work ironers must be equipped with a guard for the top rolls, so constructed as to prevent the operator from putting his hands into the rolls. This guard must consist of a screen covering which shall cover the entire top of the machine or it must consist of a screen fence not less than 12 inches in height and so placed as to enclose the four sides of the machine above the rolls. The mesh of the screening as specified above must not be larger than 2 inches.

The top of the machine may be covered with solid metal instead of a screen if an exhaust system is attached to the machine so as to carry off the heat and prevent it from being thrown off against the operators.

Note: If the fence guard is used, the guards may be attached with sockets so that they can be easily removed when padding the rolls.

D. Insurance Regulations

1. Supervision, Inspection and Employee Education

The following paragraphs dealing with Safety Supervision, Inspection and Employee Education outline plans of procedure which have been adopted by most of those bodies in the United States whose chief aim is industrial safety, and which have been successfully applied for many years by a great number of representative industrial organizations.

It will be noted that reference is made to Class A, Class B and Class C establishments and that class requirements differ. The classes have been arbitrarily based on number of employees, but it must not be inferred that plants having fewer than seventy-five employees (selected as the lower limit for complete application of Class A standards) may not greatly profit by following the procedure outlined for Class A establishments, modified as may be found advisable to meet individual plant conditions. It will be found that conscientious adherence to the principles which are the basis of these procedures--active executive supervision, definitely delegated individual responsibility with commensurate authority, constant search for and correction of physical defects and unsafe practices, and unceasing training of workmen in orderly thought and procedure--will not only reduce accident occurrence to a minimum, but will return ample dividends in increased production, in improved quality of product or service, and in more economical operation.

1.1 Supervision

1.11 Class A, B and C Establishments

There should be a General Committee of not less than three persons, one of them to be an employee in a position of authority, such as:

Manager
Superintendent
Engineer
Master Mechanic
Foreman

The duties of the committee are to:

Review and approve inspection reports.

Consider and decide upon the practicability of all recommendations. For this purpose, meetings should be held at intervals of not more than one month and written records should be kept of actions taken at such meetings.

Record and familiarize themselves with the causes of all accidents for the purpose of devising methods of preventing similar accidents.

See that new employees are properly instructed in the hazards of their work, and that employees of the various departments are educated in safe practices through the use of bulletins, printed rules or oral instructions.

Supervise the safety inspection work.

1.2 Inspection

1.21 Class A Establishments (75-150 Employees)

A competent person with knowledge of industrial safety standards should be in charge of inspection service, make regular weekly inspections of the plant, and fill out and sign weekly reports showing conditions in the plant and recommendations for changes. These reports should be kept on file in the office and be available to the supervising authority at all times. Standard blanks for inspection reports may be furnished by the insurance carrier.
The duties of the safety inspector are to:
Inspect the plant and plant equipment and make specific written recommendations for the removal of hazards. Such recommendations should cover all matters relative to safety.
Inspect for maintenance of safeguards, condition of hand tools, general order and arrangement of materials, cleanliness, ventilation, lighting, etc.
Make, or arrange for, regular inspections of special equipment such as elevators, cranes, hoisting chains, engine and motor stops, pressure vessels, etc., and keep written records of each such inspection.
Inspect for fire hazards; inspect automatic sprinkler systems, extinguishers and fire hose; see that fire pails (water and sand) are full and that exits are clear.
See that drawings and specifications for new machinery cover, in accordance with standards, the elimination or guarding of dangerous features such as gears, set-screws, sprockets, couplings, etc. Inspect new machinery before it is placed in operation and see that necessary standard safeguards are in place.

1.22 Class B Establishments (150-500 Employees)

A competent person with knowledge of industrial safety standards should be in charge of inspection service, make regular weekly inspections of the plant, and fill out and sign weekly reports showing conditions in the plant and recommendations for changes. These reports should be kept on file in the office and be available to the supervising authority at all times. Standard blanks for inspection reports may be furnished by the insurance carrier.
The duties of the safety inspector are to:
Inspect the plant and plant equipment and make specific written recommendations for the removal of hazards. Such recommendations should cover all matters relative to safety.
Inspect for maintenance of safeguards, conditions of hand tools, general order and arrangement of materials, cleanliness, ventilation, lighting, etc.
Make, or arrange for, regular inspections of special equipment such as elevators, cranes, hoisting chains, engine and motor stops, pressure vessels, and keep written records of each such inspection.

Inspect for fire hazards; inspect automatic sprinkler systems, extinguishers and fire hose; see that fire pails (water and sand) are full and that exits are clear. See that drawings and specifications for new machinery cover, in accordance with standards, the elimination or guarding of dangerous features such as gears, set-screws, sprockets, couplings. Inspect new machinery before it is placed in operation and see that necessary standard safeguards are in place.

Investigate, record and report on all accidents.

One or more members of the General Committee (other than the safety inspector if he is a member of the Committee) should make a thorough inspection of the plant at least once each month, and submit a signed report of his (or their) recommendations for the elimination of accident causes.

1.25 Class C Establishments (More Than 500 Employees)

There should be a safety inspector who has knowledge of industrial safety standards, and who devotes at least one-half of his entire time to safety work. Such inspector should fill out and sign weekly reports showing the conditions in the plant and recommendations for changes. These reports should be kept on file in the office and be available to the supervising authority at all times.

The duties of the safety inspector are to:

Inspect the plant and plant equipment and make specific written recommendations for the removal of hazards. Such recommendations should cover all matters relative to safety.

Inspect for maintenance of safeguards, condition of hand tools, general order and arrangement of materials, cleanliness, ventilation, lighting, etc.

Make, or arrange for, regular inspections of special equipment such as elevators, cranes, hoisting chains, engine and motor stops, pressure vessels, and keep written records of each such inspection.

Inspect for fire hazards; inspect automatic sprinkler systems, extinguishers and fire hose; see that fire pails (water and sand) are full and that exits are clear.

See that drawings and specifications for new machinery cover, in accordance with standards, the elimination or guarding of dangerous features such as gears, set screws, sprockets, couplings. Inspect new machinery before it is placed in operation and see that necessary standard safeguards are in place.

Investigate, record and report on all accidents.

There should be an Inspection Committee of not less than three members, composed of foremen and workmen. The personnel of the committee should be changed at regular intervals, preferably by rotation.

The duties of the committee are to:

Make not less than one thorough inspection of the plant each

month and submit written reports containing recommendations for safeguarding the plant and improving safety conditions, including those conditions specifically referred to under the duties of the safety inspector. Such reports should be signed by members of the Committee.

1.3 Employee Education

1.31 Class A Establishments (75-150 Employees)

Suitably located bulletin boards should be provided, on which safety bulletins (which should be changed at least monthly), safety orders, rules and information should be posted.

1.32 Class B Establishments (150-500 Employees)

Suitably located bulletin boards should be provided, on which safety bulletins (which should be changed at least monthly), safety orders, rules and information should be posted.

In addition, one of the following alternative procedures should be followed:

(a) At intervals of not more than six months, meetings of all employees of the plant should be held, at which meetings talks on safety should be given. In plants where it is advisable to have departmental semi-annual meetings instead of single meetings of the entire plant personnel, such departmental meetings are satisfactory if they include attendance of all plant employees. A complete record of each such meeting should be kept, giving the date, attendance, speakers, topics discussed, etc.

(b) Meetings of the foremen should be held at least quarterly, and at least 75% of the foremen should be present at each of the meetings. A discussion of plant safety should occupy at least thirty minutes of each meeting. Records of each quarterly meeting of the foremen should be kept, giving the date, topics discussed, actions taken and names of foremen and plant executives who were present. These records should clearly indicate that a genuine effort is being made to keep accidents at a minimum through supervision by the foremen, and that such quarterly meetings aid the foremen in this work.

(c) A magazine or pamphlet should be distributed at least once a month. A fair percentage of its contents should be devoted to safety.

(d) Safety literature, such as notices on pay envelopes, should be distributed at least once a month.

1.33 Class C Establishments (More Than 500 Employees)

Suitably located bulletin boards should be provided throughout the plant, on which safety bulletins (which should be changed at least monthly), safety orders, rules and information should be posted.

Warnings, signs and printed operating rules should be posted and safety literature, such as notices on pay envelopes, should be distributed at least once a month.

In addition, one of the following alternative procedures should be followed:

(a) At intervals of not more than six months meetings of all employees of the plant should be held, at which meetings talks on safety should be given. In plants where it is advisable to have departmental semi-annual meetings instead of single meetings of the entire plant personnel, such departmental meetings are satisfactory if they include attendance of all plant employees. A complete record of each such meeting should be kept, giving the date, attendance, speakers, topics discussed, etc.

(b) Meetings of the foremen should be held at least quarterly, and at least 75% of the foremen should be present at each of the meetings. A discussion of plant safety should occupy at least thirty minutes of each meeting. Records of each quarterly meeting of the foremen should be kept, giving the date, topics discussed, actions taken and names of foremen and plant executives who were present. These records should clearly indicate that a genuine effort is being made to keep accidents at a minimum through supervision by the foremen, and that such quarterly meetings aid the foremen in this work.

(c) A magazine or pamphlet should be distributed at least once a month. A fair percentage of its contents should be devoted to safety.

1.4 The Foreman's Responsibility

To a great extent, the success of a plant safety program depends upon the attitude of the foreman. From a safety standpoint, the foreman is a key man in the organization. He is closer to the workman than is the management. He is closer to the management than is the workman. He is responsible for the production activities of the men under him and should be responsible for their safety. If he believes in safety, practices and insists upon safety, safety will be the result.

It should be among the responsibilities of the foreman:

To assure himself that each employee entering his department is fully informed of all hazards to which he may be exposed and which may produce injury, be that injury the result of accident, injurious substance or harmful working conditions.

To see that each employee is fully instructed in the safe performance of the duties assigned to him.

To see that any injury or illness of an employee under his direction is immediately reported to the proper authority.

To see that no employee under his direction continues work in any operation for which he or she is physically or mentally unfit.

To enforce the use of protective devices.

To see that mechanical guards and safety devices are, at

all times, in place and properly maintained.
To see that each employee wears, at all times, safe and appropriate clothing.

2. First Aid and Hospital

First aid and hospital facilities are grouped under three headings:

First Aid
Dispensary
Emergency Hospital

2.1 First Aid

A suitable and easily accessible space, which insures a reasonable amount of privacy both to the injured and the person rendering first aid, should be set aside for the administration of first aid. There should be provided therein two chairs, a small table, and washing facilities consisting of running water, basin, towel and soap.
A minimum of three persons for each shift in every establishment should be instructed and trained by a physician or trained nurse in the principles and application of first aid, and should have charge of the first aid kit and its maintenance. Such kits should be for first aid use only. In every plant and at all times, there should be present at least one first aid kit. Cases for first aid kits should preferably be made either of metal or glass, so constructed as to exclude dust, and kept clean. Once a month or more often, the kit or kits should be checked as to contents. Following the use of any of the material or contents of the kit, it should be immediately replaced.
The contents of each first aid case should be substantially as follows:

Instruments:
1 pair scissors.
3 inch splinter forceps.
Tourniquet.
Graduated medicine glass.

Drugs:
2 oz. or a minimum of 10 ampoules of aromatic spirits of ammonia.
Boric acid--liquid, powder or tablet form to make 4% solution.
2 oz. or a minimum of 10 ampoules of tincture of iodine, half strength.
2 collapsible tubes, 3 oz., of burn dressing or at least 6 individual tubes.
2 oz. castor oil (for eye injuries).

Dressings:
1 doz. sterile guaze bandages, assorted sizes, and one dozen assorted compresses in sealed packets.
1 five yard spool of 1-inch adhesive plaster.
3 packages, $\frac{1}{2}$ oz. each, of absorbent cotton.

Splints of assorted sizes for fractures, or wire splints.
Wooden applicators wound with cotton.
1 doz. wooden tongue depressors.

All bottles or other containers of drugs or other substances should be clearly labeled and the specific purpose for which the contents are to be used should be marked thereon.

2.2 Dispensary

A dispensary building or room on the premises, with running hot and cold water, should be set apart from all workrooms and contain a stretcher and at least the equivalent of a standard first aid outfit as specified in Paragraph 2.1 of this section.

A nurse who is a graduate nurse should devote his or her entire time to attendance at the plant dispensary during working hours. This should be interpreted as meaning in the dispensary or in a room adjoining it, and instantly available at all times for the treatment of accident cases. This should not prevent the nurse from assuming auxiliary work during the time he or she is not needed for dispensary service provided, however, such work is not incompatible with emergency dispensary duties and is not given precedence over the nursing work.

2.3 Emergency Hospital

The emergency hospital should be a building, room, or rooms set apart and on the premises.

A nurse should be provided in accordance with Paragraph 2.2.

A doctor licensed to practice medicine in the state having jurisdiction should be available to call during all working hours and should make at least semi-weekly visits to supervise the medical work of the plant.

If a doctor licensed in the state having jurisdiction is present during all working hours, such arrangement is acceptable in lieu of the requirements of the two paragraphs immediately preceding.

The hospital should contain the following equipment:

Operating table, instruments and instrument case.
Couch and chairs.
Table for dressings.
Sterilizers for instruments and dressings.
Drugs, medicines, splints, dressings, basin, etc. The supply of drugs, dressings, etc., should be in accordance with the needs and personnel of the plant as specified by the plant physician.
Hot and cold running water.
Lighting facilities--complete.

Stretchers should be centrally located throughout the plant.

The following instruments should be considered a minimum requirement in states having no official standard for equipment. In states having laws bearing on this item, such laws shall apply.

1 bandage scissors.
1 sharp-pointed dressing scissors.
1 blunt dressing scissors.
1 medium sized thumb forcep.
1 splinter forcep.
1 probe, silver.
1 groove, director.
6 small artery clamps.
1 hypodermic.
1 razor.
2 scalpels.
1 doz. assorted suturing needles.
1 needle holder.
1 tourniquet.
6 tubes of catgut plain, No. 1 or 2.
6 tubes of catgut chronic, No. 1 or 2.
1 hank of silkworm gut.
1 card of black suturing silk.
Other instruments as required by the attending physician.

3. Resuscitation

4. Personal Protection

4.1 Clothing--General

In selecting work clothing, consideration should first be given to the hazards to which its wearer may be exposed and those types should be selected which will reduce the hazards to the lowest feasible minimum in each case. There are available safe work garments and protective clothing of many different types, each designated for a specific purpose.
In general, work garments should be reasonably snug; there should be no loose flaps, or strings, and pockets, if any, should be few and rather small. Long, loose coats or "dusters" should never be worn near revolving or reciprocating machine parts.
Torn or ragged clothing creates a hazard and should not be worn by persons at work.
Neckties should not be worn by employees who operate boring mills, drill presses, lathes and similar machines in which parts of materials revolve.
Sharp or pointed objects, explosives and materials of a flammable nature should never be carried in pockets and pockets and cuffs which might collect flammable or explosive dust or waste should not be used.
Finger rings and key or watch chains should not be worn by persons at work; if caught in machinery or on a live electrical part they may cause injury and in many events may increase its severity.
Collars, eye shades, cap visors, spectacle frames and similar articles made of celluloid or other flammable material should not be used.
Work clothing which has been worn by one workman should not

be reissued to another workman without first having been thoroughly sterilised.

Hats and Caps

When hazards warrant it, "hard-boiled" hats are desirable to break the force of blows caused by falling objects, etc. Where workers may strike their heads against beams or projecting objects, well padded caps offer good protection.

Aprons

Aprons should not be worn near revolving or reciprocating machine parts. They should not be worn near fire unless made of heat-resistant material.

Where the use of an apron by machine operators or workers exposed to similar hazards is absolutely necessary, the skirt should be separate from the bib and both should be very lightly secured to the body so that, should either the bib or the skirt be caught in a moving part it may be instantly removed.

Gloves

The hands of workmen who handle sharp-edged materials should be protected by gloves or suitable hand leathers or pads. Gloves should not be worn while operating drills, punch presses, lathes, or other machines around which the hands may be exposed to moving parts.

The hands of workmen who use knives, as in cutting or boning meat, fish, etc., may be protected by steel mesh gloves.

Approved types of rubber gloves should be used for protection against electric shock.

4.5 Shoes and Leggings

Work shoes should have toe boxes of the safety type.

Work shoes for women should have low heels.

Shoes with badly run-over heels should not be worn, as they may cause injury due to turning of the ankle or to slipping.

Smooth rubber soles and rubber heels should not be worn on wet or oily floors, as they may cause slipping.

Soles which are very thin or in which there are holes, constitute a hazard and should not be worn at work.

Workers exposed to unusual hazards, such as are present in the handling of acids, caustics, etc., should wear shoes or boots designed especially to provide protection against the particular hazard involved. Such footwear may be made of rubber, especially treated leather, wood and other suitable materials.

Workers exposed to hazards such as are present in the handling of molten metals, hot or corrosive liquids, etc., should wear snug-fitting leggings made of suitable material and of a type which can be instantly removed. Similarly, they should wear foot protection closely fitting the feet and ankles, so designed that the material handled cannot enter the shoes, and of a type easily and quickly removable from the feet.

Shoe laces should be kept tied.
Suitable leggings should be worn by employees who are required to climb ladders or poles.

4.6 Eye Protection

Eye protection should be afforded employees performing operations which directly endanger their eyes. Included in such operations are the pouring or handling of molten metals or corrosive liquids, milling, chipping, scaling, cutting and welding, dry grinding, sand blasting, etc. Eye protection should also be afforded employees exposed to gases or fumes injurious to the eye.
In those cases where the work done also endangers other employees, compelled by conditions to work in proximity to such operations, those other employees should be afforded eye protection.
Eye protection should consist of goggles, except in those cases where eye hazards have been effectively removed by the interposition of suitable screens or shields, or by the wearing of suitable helmets or masks.
Goggles should meet the following requirements:
Where the glare exists, properly colored lenses should be used.
Where danger of impact exists, lenses should be so strong and so framed as to effectively reduce the danger of eye injury from broken pieces of lens.
Lenses which interfere with vision because of starring, frosting, etc., should not be used.
Frames should be light and adjustable to the face. In many, but not in all, operations frames should be equipped with side screens.
Where there are gases or fumes injurious to the eye, gas-tight goggles should be used.
Goggles which have been worn by one workman should not be reissued to another workman without first having been sterilized.

5. Housekeeping and Storage of Materials

5.1 Housekeeping

Good housekeeping practices should be observed in all parts of the plant and yard.
Work spaces should be kept clean and orderly.
Aisle spaces should be plainly defined and should be kept free from obstructions.
Walkways should not be slippery. Their surfaces should be made of anti-slip material.
Floors should be kept free from protruding nails, splinters, holes and loose boards, and should not be uneven.
Floors should be kept free from oil and water.
Safe clearances should be provided at the sides of pathways, driveways and yard railroad tracks.
Tools should not be placed or left on planer beds or moving

parts of machines. Tools should not be left on floors, platforms, scaffolds, stairs, ladders, ledges or rafters. Extreme care should be taken to prevent tools falling from any elevation.
Lockers, cribs, bins or storerooms should be provided for tool storage.
Material moved on trucks should be piled so that it cannot fall off and does not project dangerously.
When repair work is being done, nearby workmen should be protected. Guard rails and warning signs should be used.
Temporary lighting should be used when necessary. Tools and debris should be removed immediately after the completion of the work.
Spaces under benches and stairways, in closets and cupboards, etc., should be inspected regularly and kept free from refuse of all kinds.
Rubbish should not be allowed to remain in lavatories, on benches, on tops of lockers or in other improper places.
Bottles, papers and lunch remains should not be left lying about.
Metal refuse cans should be provided and used, and should be emptied daily.
Oily rags, waste, etc., should be kept only in covered metal containers.
Dismantled or inactive equipment should be moved to a safe storage place. There should be no "junk pile" in the yard.
Where possible, bins or enclosed spaces should be provided for materials to be saved. All discarded objects should be permanently disposed of.
Nails should be removed from boards even though the boards are otherwise safely piled and stored.

5.2 Storage of Materials

Whether inside or outside of buildings, materials which are stored should be so placed and so piled that they will not create hazards.
Materials should not be stacked in delivery entrances, but should be moved immediately to proper storage spaces.
Stored materials should be properly cross tied, piled, cradled, packed, chocked or blocked and arranged so that there will be no danger of their collapsing, falling or slipping.
Stored materials should not project into aisles, passageways or work spaces and should be accessible for safe removal.

6. Sanitation

6.1 Water Supply

An adequate supply of clean, cool, wholesome and safe drinking water should be provided in all places of employment.
It should be readily accessible to all employees. No drinking water supply should be permitted in a room or portion of a plant where toxic substances, such as lead, are handled

or used.
All water furnished for drinking purposes should be from a source approved by the health authorities having jurisdiction. When a source of safe untreated water is not available, the water should be rendered safe for human consumption as the health authorities shall direct.
There should be no connection, open or potential, between the drinking water system and any system furnishing water for other uses, unless the latter is from a source approved as being safe for human consumption by health authorities having jurisdiction.
Where water unfit for drinking purposes is intended for industrial processes or fire protection, notice should be posted stating clearly that such water is unsafe and is not to be used for drinking. Every reasonable effort should be made to prevent its being so used.
In all instances where water is cooled by ice, the construction of the container should be such that the ice does not come in contact with the water.
The common drinking cup should be prohibited.
Sodium chloride tablets should be provided in a closed container located near the drinking water supply in all plants where excessive heat is encountered by employees. Directions as to their use should be plainly shown on the container. Their location and use should be at the recommendation of the plant physician.
When individual drinking cups (to be used but once) are supplied, there should be provided a suitable container for unused cups and also a receptacle for used cups.
Where drinking fountains are provided, they should be of a type and construction approved by the health authorities having jurisdiction.
Open or covered containers for drinking water, such as barrels, pails or tanks from which the water must be dipped or poured, should not be allowed.

6.2 Spitting

Spitting upon the walls, floors, workplaces or stairs of any establishment should be prohibited.
If cuspidors are provided they should be of such construction that they can be cleaned and disinfected. They should be cleaned often enough, and at least daily, to prevent them from becoming in any way a menace to health.

6.3 Waste Disposal

Whenever a receptacle is used for waste or refuse which is liquid or liable to decompose, it should be non-absorbent and so constructed that it will not leak and may be conveniently and thoroughly cleaned. It should also be maintained in a sanitary condition.
All sweepings, waste, refuse and garbage should be removed outside of working hours, in such a manner as to avoid

creating a menace to health. However, they should be removed as often as is necessary to maintain the place of employment in a sanitary condition.

6.4 Inspection

Wherever mechanical equipment is used in connection with sanitation, periodic inspections should be made to assure the proper operation of such equipment, and records of such inspections should be kept.

6.5 Miscellaneous Requirements

Every place of employment should be constructed, so far as is reasonably practicable, in such a manner as to prevent the entrance or harboring of rats, insects, or vermin of any kind.

The employment of persons suffering from any communicable disease should be governed by the rules and regulations of the health authorities having jurisdiction.

No person should be allowed to use any workroom or place of employment as living or sleeping quarters or for the consumption of food in any form.

6.6 Hazardous Processes

All materials used in industrial processes, such as hair, rags, waste, papers and discarded clothing, which are likely to convey the causative agents of infectious diseases, should be thoroughly disinfected before being processed.

No person should be employed in handling such materials who has not been successfully vaccinated against smallpox within four years.

Standards with respect to protective devices (such as exhaust hoods, shields, positive pressure helmets and masks, protective clothing, etc.), are contained in other sections of this handbook.

6.7 Personal Service Rooms

6.71 General

All personal service rooms should be, so far as possible, screened and otherwise protected so as to prevent the entrance or harboring of rats, insects or vermin of any kind in such quarters, and they should be maintained in a sanitary condition.

All inside personal service rooms should be mechanically ventilated and all exhaust ducts from such rooms should discharge to the outside air.

6.72 Dressing Rooms for Men

Dressing rooms should be provided for men wherever the work performed involved excessive exposure to dust, dirt, heat, fumes, vapor, or moisture.

Suitable clothes hooks should be supplied for all employees. For employees whose clothes are exposed to contamination by poisonous, infectious, or irritating material, two separate lockers should be provided for each employee; one for the work clothes and one for the street clothes.

Where the process in which the worker is engaged is such that his work clothes become wet or require washing between shifts, they should be so cared for that dry clothes are assured for his return to work.

6.73 Retiring and Dressing Rooms for Women

Where 10 or more women are employed and a retiring room is not furnished, adequate retiring and dressing space should be provided and made suitable for the use of women employees. The minimum space provided for a retiring room for 10 women should be 60 square feet. The minimum increased space for more than 10 should be at least 2 square feet for each additional woman employed.

At least one couch or bed should be provided in every place where more than 10 women are employed. The number of such beds or couches provided should be as follows: 10 to 100 women, one bed; 100 to 250 women, two beds; and one additional bed for each additional 250 women employed.

A separate clothes hook for each female employee should be provided in the dressing room which she uses.

6.74 Lunch Rooms

In all places of employment where employees are permitted to lunch on the premises, space suitable for that purpose should be provided and should be adequate for the maximum number of employees who may use such space at one time.

Eating outside of designated lunchrooms should be forbidden in plants where there is exposure to toxic dusts.

A covered non-absorbent receptacle should be provided for disposing of all waste food and employees should use it for the disposal of all such materials. Such receptacles should be cleaned often enough, and at least daily, to prevent them from becoming, in any way, a menace to health.

No employee should be permitted to partake of any part of his lunch or to eat food at any time where there is present any industrial poison or other substance that may be injurious to his or her health.

In every establishment where there is exposure to injurious dusts or other toxic materials, a separate lunch room should be maintained unless it is convenient for the employees to lunch away from the premises. The following number of square feet per person, based on the maximum number of persons using the room at one time, should be provided:

Persons	Sq. Ft.
25 and less	8
25 --- 74	7
75 --- 149	6
150 --- 499	5
500 or more	4

6.8 Toilet Facilities in General

Adequate water closets, chemical closets or privies, separate for each sex, should be provided in every place of employment.

Covered, non-absorbent receptacles should be kept in all toilet rooms used by females.

An adequate supply of toilet paper should be provided for every toilet facility.

Unless the general washing facilities are on the same floor as in close proximity to the toilet rooms, adequate washing facilities should be provided in every toilet room or adjacent thereto.

Toilet rooms should be readily accessible to employees using them. Toilets should not be more than one floor above or below the regular place of work of the persons using them.

Toilet facilities (closets) should be provided for each sex according to the following table. The number to be provided for each sex should in every case be based on the maximum number of persons of that sex at work in the plant at any one time. When persons other than employees are permitted the use of toilet facilities on the premises, a reasonable allowance should be made for such other persons in estimating the minimum number of toilet facilities required.

Number of Persons	Minimum number of facilities
1 to 9	1
10 to 24	2
25 to 49	3
50 to 100	5
Over 100	1 for each additional 30 persons

Whenever urinals are provided, one facility less than the above specified number of facilities may be provided, for males, for each urinal, except that the number of facilities in such cases may not be reduced to less than two-thirds of the number specified above and in no case to less than one. Two feet of acid-resisting porcelain enamel urinal may be considered as equivalent to one urinal.

6.9 Washing Facilities

Adequate facilities for maintaining personal cleanliness should be provided in every place of employment, should be convenient for the employees for whom they are provided, and should be maintained in a sanitary condition. The common towel should be prohibited.

Individual towels of cloth or paper should be provided and proper receptacles for used towels should be maintained. Apparatus for otherwise drying the hands may be substituted for towels only after approval by the proper authority.

At least one lavatory (wash basin) with adequate water supply should be provided for every 10 employees or portion

thereof, up to 100 persons, and one lavatory for each additional 15 persons or portion thereof. Twenty-four inches of sink with individual faucet should be considered as equivalent to one basin. Soap in a suitable dispensing container should be provided at each wash place. A lavatory, supplied with hot and cold water from one faucet, should be provided for every 5 employees exposed to skin contamination by poisonous, infectious, or irritating material.

One shower bath, with ample supply of hot and cold water from one fixture, should be provided for every 15 workers or portion thereof exposed to excessive heat, or to skin contamination by poisonous, infectious, or irritating material.

7. Illumination

The advantages of good illumination, both natural and artificial, and of bright and cheerful interior surroundings, include the reduction of accidents, greater accuracy in workmanship resulting in improved quality of goods, increased production, less eyestrain, greater cleanliness, more order and neatness in the plant, and easier employee supervision.

7.1 Recommended Minimum Levels of Illumination

Illumination by daylight or artificial light should be supplied for traversed spaces such as hallways, roadways, etc., during working hours, and for work when attended by operators. In the following table, minimum levels of illumination are listed. Values greater than these minima may well be used.

TABLE 7A

7.11 Illumination on Traversed Spaces

	Recommended Minimum Foot-Candles
Roadways, yard thoroughfares	2-1
Storage spaces, aisles and passageways in workrooms, excepting exits and passageways leading thereto	3-2
Spaces such as stairways, hallways, exits and passages leading thereto.	5-3
Spaces such as locker rooms, wash rooms, toilet rooms, and passageways where there are exposed moving machines, hot pipes, or live electric parts	6-4

7.12 Illumination at the Work

Where discrimination of detail is not essential. Work such as handling material of a coarse nature, grinding clay products, rough sorting, coal and ash handling, foundry charging	5-3
Where slight discrimination of detail is essential. Work such as rough machining, rough assembling, rough bench work, rough forging, grain milling . .	10-5
Where moderate discrimination of detail is essential. Work such as machining, assembly work, bench work, fine core making in foundries.	15-10
Where close discrimination of detail is essential. Work such as fine lathe work, pattern making, tool making, weaving or sewing light-colored silk or woolen textiles, office work, accounting, typewriting.	20-12
Where discrimination of minute detail is essential. Work such as drafting, weaving or sewing dark colored material, very fine inspection or inspection of very dark goods.	100-25

The preceding table gives the range of minimum illumination values that are considered desirable for different classes of work. These values are based upon practice established through years of experience. Elderly persons or persons with defective eyesight require more light than do those having perfect vision. A range of foot-candle values is given for each group of operations. In modern practice it will usually be found desirable to select values in or even beyond the upper portion of the range.

It is recognized that any specific process when carried on in different factories is performed with different degrees of fineness and with other variations, so that one factory may need more illumination than another for the same class of work. In the table, ranges of foot-candle values are given to correspond to the variations actually existing in practice. Attention is called to the fact that the values in the table are operating values, that is, they apply to measurements of the lighting system in ordinary use, not simply when the lamps and reflectors are new and clean.

7.2 Diffusion and Distribution of Light.

Lighting, whether natural or artificial, should be such as to provide good distribution of light and to avoid glare, objectionable shadows and extreme contrasts. In artificial lighting, lamps should be so installed in regard to their height, location and spacing and should be so equipped with reflectors, shades or other suitable accessories as to accomplish these objects.

Bare light sources, such as exposed lamp filaments, located within the ordinary field of the worker's vision are presumptive evidence of glare.

The principal causes of glare are:

The light source may be too bright; that is, it may have too high a candlepower per square inch of area.

The light source may be too powerful for comfort; that is, it may have too great a total candlepower in the direction of the eye.

A given light source may be located at too short a distance from the eye or it may lie too near the center of the field of vision for comfort; that is, within too small an angle from the ordinary line of sight.

The contrast between the light source and its darker surroundings may be too great.

The time of exposure may be too great; that is, the eye may be subjected to the strain caused by a light source of given strength within the field of vision for too long a time.

Glare from natural lighting may frequently be reduced by the use of refracting or diffusing glass in windows and skylights, and by the rearrangement of machines and benches so that operators are not required to face windows.

7.3 Exit and Emergency Lighting

The lighting to be provided in all important stairways and all exits from work places and in the passageways related thereto should be so supplied that it will not be subject to failure of the room or work-space lighting from internal causes. In artificial illumination, the service for exit and emergency lighting should preferably be from an independent connection or connections extending back to the main service entrance. In cases of unusual danger which may exist on account of the type of building or nature of the work, crowded conditions, or lack of suitable exit space, an independent service should be assured by connecting to a separate source of supply without or within the building. During the hours of occupancy when daylight is lacking, this separate source of supply should be connected so as to function continuously or to come on automatically upon failure of the regular lighting service.

7.4 Maintaining the Level of Illumination

The proper maintenance of equipment for both natural and artificial lighting is essential. Systems which are adequate when first installed will soon deteriorate unless properly maintained. For continued effectiveness and economy in lighting, the factory owner should establish a regular definite system of maintenance so that skylights, side windows, lamps and accessories are at all times kept clean, in proper adjustment and in good repair. Means for easy access to all lighting units should be provided for employees in charge of their maintenance. Walls and ceilings should be repainted at regular intervals and preferably in light tones. This is especially true where systems of indirect lighting are used. Especially in connection with the maintenance of lighting

systems, attention is called to the desirability of having available in the factory an instrument with which the foot-candles of illumination received at any point can be measured. One instrument, the foot-candle meter, while not designed for precise measurements, has a wide field of usefulness because, with a little practice, determinations are easily made and are accurate enough for most practical purposes. The foot-candle meter is small, light in weight and entirely self-contained. Illumination is read directly from the scale without computation or manipulation.
By measuring light actually delivered to the work, the foot-candle meter automatically reveals the combined effect of all possible causes of deterioration. Ignorance of the magnitude of deterioration has often been the cause of inadequate maintenance.

8. Building Exits

Not less than two means of exit should be provided from each and every floor, including basements, of every building or section thereof.
All doors used in connection with exits should swing with the exit travel. Doors sliding across the exit travel may be permitted in some localities by the authorities having jurisdiction. Vertical sliding doors and rolling shutters should not be used as exits.
All doors used in connection with exits should be so arranged that they may be readily opened at any time from the side from which egress is made. Locks, if provided, should not require keys to open them from the inside.
All exits should be so located that they are visible and readily accessible. All stairs which may be used for exit purposes should be so marked as to indicate clearly the direction of egress to the street.
A door should not open immediately on a flight of stairs, but on a landing which should be at least as deep as the width of the door.
All stairways, except in special cases where open stairways are permitted, should be enclosed in standard fire resistant or fire retardant stair shafts. Enclosures should include all landings or parts of floors between stairways which lie in the path of travel up or down stairways, so that, once inside the enclosure, persons may go from any part of the stairway to the outside exit without leaving the enclosure.
Outside stairs should be so arranged that they will be exposed by the smallest possible number of window and door openings. Openings other than those used as a means of exit should preferably have metal frames and wired glass. There should be no transoms over doors.
Spiral stairs and ladders in any form are not recognized as standard exits.
Exits and exit passageways should be kept clear at all times.

To that end, periodic inspections should be made by a person with adequate authority and preferably as recommended in Section 1.2.

9. Protection Against Tripping and Falling

9.1 Stairs

Stair hand-rails should be not more than 34 inches nor less than 30 inches high, measured from the top of the rail to the surface of the tread in line with the face of the riser at the forward edge of the tread.

On each flight of stairs having four or more risers, hand-rails should be provided as follows:

On all open sides.

On one side of enclosed stairways less than 44 inches in width.

On both sides of enclosed stairways 44 inches or more but less than 88 inches in width.

On both sides and in center of stairways 88 inches or more in width.

9.2 Railings and Toe-Boards--

Railings should be 42 inches high, with an intermediate rail half-way between the top rail and the floor, and should be permanent, substantial, smooth and free from protruding nails, bolts or splinters.

Posts should be not more than eight feet apart.

Pipe for railings should be 1½ inches Iron Pipe Size or larger. Metal shapes or bars should be equivalent in strength to 1½ inch by 1½ inch by 3/16 inch angles.

For wood railings, posts should be 2 by 4 inches or larger. Upper rails should be 2 by 4 inches, or consist of two 1 by 4 inch strips, one at the top and one at the side of the posts. Intermediate rails may be 1 by 4 inches or larger. All lumber should be dressed, 1/8 inch tolerance being permitted.

Rails should be on that side of the posts which gives the best protection and support. Where panels are fitted with substantial expanded metal or wire mesh, intermediate rails may be omitted.

Toe-boards should be at least three inches, and preferably six inches, high, and should be of wood, metal or other substantial material, or of metal grille not exceeding one inch mesh.

9.3 Floor, Wall and Hatchway Openings

All floor openings should be enclosed, guarded with standard railings and toe-boards, or protected by safety covers with flush hinges. When open, covers should provide protection equivalent to standard railings.

All wall openings should be solidly enclosed or provided with standard railings and toe-boards or their equivalent.

Railings or enclosures may be hinged to open inwardly, but should be so fastened that they cannot be removed entirely.

Hatchway openings should be protected by one of the following:
Standard railing and toe-boards.
Hatch covers.
Solid, slat or grille-work gates 42 inches high.
When in use, openings should be protected on all sides except those on which work is actually being done.

9.4 Elevated Runways and Platforms
Standard railings and toe-boards should be provided on all runways and platforms which are five or more feet above floor or ground level. Toe-boards need not be provided on platforms in buildings used exclusively for lumber storage.

9.5 Ladders
Wood for side rails and treads should be thoroughly seasoned, smooth and free from decay, faults, splinters or sharp edges. It should be red, white or Sitka spruce, or wood of equivalent strength.
Wood for rungs or cleats should be white ash, or wood equivalent thereto in strength and resistance to wear.
Wood treads should be inset in the side rails not less than 3/16 of an inch. All steps should be fastened securely at both ends.
Portable ladders should not exceed 30 feet in height or length, and should be equipped with non-slip bases. Hooked tops should be used where conditions permit.
Step ladders should not exceed 20 feet in height.
Wooden ladders or ladder parts should not be painted. Paint may conceal defects in the wood and may promote dry rot. Linseed oil, clear varnish or clear lacquer form satisfactory protective coatings.

10. Elevators

11. Traveling Cranes

12. Handling and Transportation of Material
Hand leathers or gloves should be worn by persons handling rough or sharp material.
Protective clothing should be worn by persons handling corrosive material.
Approved devices for the protection of respiratory organs should be worn by persons exposed to an excessive amount of dust.
Suitable goggles should be worn by persons exposed to eye hazards such as flying objects, dusts, excessive glare, etc.
Hand trucks and wheelbarrows should be equipped with knuckle guards.
Hand trucks used for handling barrels and carboys should be designed for that specific purpose.
Tote boxes and pans, platforms, wheelbarrows, hand trucks etc. should be kept free from splinters, rough edges and similar defects, and should otherwise be maintained in safe working condition.
Power vehicles should be inspected at regular intervals,

particular attention being paid to the steering mechanisms, brakes and warning signals. Only qualified and duly authorized persons should be permitted to operate power-driven vehicles.

While motor trucks are being loaded or unloaded, their engines should be stopped, their brakes should be set and, under certain adverse grade conditions, their wheels should be blocked.

Transportation routes should be so planned as to minimize cross flow of traffic and to avoid blind turns and corners. One-way traffic is desirable. Transportation routes should be clearly marked.

Whether illumination is natural or artificial, it should be sufficient to provide good visibility. Details are presented in the section on illumination. The use of mirrors, so placed that persons can see around blind corners, is recommended. Doorway clearances and aisle widths should be adequate for the safe transportation of material.

Spaces for material storage should be used only for that purpose and should be clearly marked.

Where such steps are necessary to prevent piled materials from falling, such materials should be cross tied, stacks should be stepped back, and racks or skids should be provided.

The uses of lift trucks and tiering machines in stacking material is recommended.

Conveying equipment should be guarded as is detailed in other sections of this handbook. It should be inspected at regular intervals and maintained in a safe working condition.

13. Steam Boilers

14. Unfired Pressure Vessels

15. Engines and Turbines

16. Identification of Piping

The principal requirements for a standard scheme for the identification of piping are: distinguishability, flexibility, inclusiveness, simplicity, practicality and rationality.

The standard scheme herein presented meets as many of these requirements as the present state of the art will permit. It is therefore hoped that industry as a whole will gradually adopt it, even though it is recognized that the supplanting of present systems and the adoption of the new one must be accomplished gradually. It will be noted that this standard scheme, while establishing a universal standard, leaves the maximum freedom of action to each branch of industry.

16.1 Method of Identification

At conspicuous places throughout a piping system, color bands should be painted on the pipes to designate to which one of five main classes the contents of each pipe belongs.

If desired, the entire length of each pipe may be painted its main classification color.
Further, the actual contents of a pipe may be indicated by, preferably, a stenciled legend giving the name of its contents in full or abbreviated form. These legends should be placed on the colored bands. The identification scheme may be extended by the use of contrastingly colored stripes placed at the edges of the colored bands.
The bands, legends, and stripes should be placed at intervals throughout the piping system, preferably adjacent to valves and fittings, to assure ready recognition during operation and repairs and at times of emergency.

16.2 Main Classification by Color

This part of the scheme is intended to identify the main classes into which the materials in the pipes belong. It establishes a basic fundamental principle applicable to all schemes for identifying pipes and is intended to designate the pipe contents as belonging to a specific class of materials which are safe, dangerous or otherwise. The inclusion of all systems at present in use is made readily possible with minimum change by the adoption of the following color classification. All piping should be classified according to the character of the material carried therein. Especially in an emergency, the quick identification of the contents of a pipe is of paramount importance. For this purpose, each pipe is assigned, by the nature of its contents, one of the following classifications:

Class	Color
F--Fire-protection equipment . . .	Red
D--Dangerous materials	Yellow (or orange)
S--Safe materials	Green (or the achromatic colors, white, black, gray or aluminum)
P--Protective materials	Bright blue
V--Extra valuable materials	Deep purple

The above colors have been chosen to identify the main classifications because they are readily distinguishable one from another.

16.3 Applying a Standard Identification Scheme

In applying the standard identification scheme described in Sections 16.1 and 16.2 to the piping in any establishment, the following steps should be taken in the order in which they are listed:

List all materials carried in pipes.
Assign each material to one of the five main classes: fire-protection equipment (F), dangerous materials (D), safe materials (S), protective materials (P), and extra valuable materials (V).
Group the materials assigned to each class for the purpose

of facilitating the selection of sub-class markings.
Choose between the alternative methods of (a) color bands or (b) complete color painting.
Assign a legend or color stripe or stripes to each material listed under each main classification.

16.4 Special Paints

Plant atmosphere charged with gases or vapors which react chemically with ordinary paint pigments call for the use of acid and alkali resisting paints. The American Standards Association Code A13-1928, "Scheme for Identification of Piping Systems" contains information on this subject.

17. Electrical Equipment

17.1 General Requirements

17.11 Guarding Live Parts

All live parts at voltages exceeding 300 volts to ground should be guarded, if clearance from the platform or any other permanent supporting surface for workmen are less than shown in Table 17-A.

TABLE 17-A. Minimum Clearances From Live Parts

1	2		3		4
Voltage Between Phases	Minimum vertical clearance of unguarded parts		Minimum horizontal clearance of unguarded parts		Minimum Clearance from guards to parts Radius of guard zone*
	Feet	Inches	Feet	Inches	Inches
300	7	8	3	2	2
2,300	7	9	3	3	3
6,600	7	10	3	4	4
11,000	9	0	3	6	6
22,000	9	3	3	9	9
33,000	9	6	4	0	12
44,000	9	10	4	4	16
66,000	10	5	4	11	23
88,000	11	0	5	6	30
110,000	11	7	6	1	37
132,000	12	2	6	8	44

*The guard zone means the space of minimum clearance from guards to electrical parts.

Exposed parts of equipment at 100 volts or more to ground should not be accessible to unqualified persons.

Parts over or near frequently traveled passageways, etc., should be guarded or given clearances sufficiently in excess of those specified above to insure reasonable safety.

Guards should be of sufficient rigidity and strength to prevent them from being displaced or dangerously deflected by a man slipping or falling against them. Railings are

not substitutes for complete guards, but if used, should be located at a horizontal distance of at least three feet from the nearest point of the guard zone which is less than 7½' above the floor. Insulating covering on parts exceeding 750 volts to ground should not be considered adequate protection, but for parts less than 750 volts to ground in dry places and where not exposed to mechanical injury, varnished cloth or other equivalent insulation suitable for the voltage involved may be used as a guard.

17.12 Grounding

Protective Grounding: All electrical equipment, if operating at more than 150 volts to ground, should have the exposed non-current carrying metal parts, such as frames of generator motors and switch boards, cases of transformers, lightning arrestors and switches, guard rails and screens permanently grounded.

Hazardous Locations: Electrical equipment of all voltages, in locations where explosives, or flammable gas or dust, lint, fumes, etc., exist in dangerous quantities, or where there is dampness, should be grounded.

Arrangement of Grounds: Ground connections may be made to water pipes, or other metal in proper contact with earth or bodies of water, such as penstocks, water gates, etc. When artificial grounds are necessary, metal plates buried in ground, prepared with charcoal and other chemicals to decrease the ground resistance should be used. Present day practice favors the use of metal pipes driven in the ground. This method permits a ground distributed over a wide area, and is easily installed.

Grounding equipment during repairs: Electrical equipment or conductors normally operating at more than 750 volts on or about which work is occasionally done while separated from a source of electrical energy by switches or disconnectors only, should be provided with some means, such as switches, connectors, or readily accessible ground conductors, for grounding them.

17.13 Working Space

Where required: Adequate and readily accessible working space with secure footing should be maintained about all electrical parts or equipment which require adjustment or examination when exposed while in service.

Clearance: The horisontal clearance from the farthest edge of the working space to the nearest live parts of more than 300 volts to ground, exposed after removing guards, should be not less than three feet plus the guard zone radius as given in column 4 of Table 17-A.

17.14 Identification

When necessary for safety, electrical equipment should be suitably labeled for identification. Where important, the label should specify voltage and intended use.

17.15 Illumination

Sufficient illumination should be provided in rooms and spaces where electrical apparatus or machinery is located. The means of illumination whether natural or artificial should be maintained ready for use at all times and should be in accordance with Table 17-B and should be at least 5 foot candles.

TABLE 17-B. Illumination Intensities

	Modern Practice
1 Switchboard instruments, guages, switches, etc.	2 to 4 Foot Candles
2 Switchboard with no exposed live parts	1 to 2 " "
3 Storage battery room	1 to 2 " "
4 Generating room, boiler room, pump room	2 to 4 " "
5 Stairways and passage ways where there is moving machinery, exposed live parts, etc.	3 to 5 " "
6 Any traversed space	2 to 3 " "

Note. The values shown in Table 17-B are to be measured at working surfaces, except 5 and 6 which are to be measured at floor level.

Emergency Source: A separate emergency source of illumination should be provided where an operator is required continuously, to permit the proper operation of the switchboard when the usual source of illumination is affected by disturbances.

17.16 Fire Extinguishers

Each room or space shall be provided with adequate approved fire-extinguishing appliances conveniently located and conspicuously marked.

Non-conducting extinguishers: Fire in electrical equipment should be extinguished with the vaporizing non-conducting liquid type or the carbon dioxide type, and some other inert gas type extinguishers.

17.17 Hazardous Locations

In locations where explosive or flammable gas or dust are present in dangerous quantities, all parts where sparking, arcing or dangerous heating is liable to occur should be installed in separate compartments or rooms, free from such hazardous conditions, or should be explosion proof type. Where current carrying parts, insulation of leads, or electrical devices or equipment are exposed to injury by being installed on locations where dripping oil, excessive moisture, steam, vapors, or similar agents exist, suitable shields or enclosures should be provided.

17.2 Switchboards

17.21 Material
Switchboards shall be made of non-combustible material and be kept free from moisture.

17.22 Illumination
Sufficient illumination should be provided both for the front and rear of the switchboard in accordance with Rule 17.15 and Table 17-B.

17.23 Location
Switchboards shall, where practicable, be so placed that the operator will not be endangered by any live or moving parts of machinery or equipment near the board.

17.24 Accessibility
Switchboards should be accessible to authorized operators from both sides when the connections are on the back. The space back of the board should be kept clear of rubbish and should not be used for storage. Clearance for working space in back of board should be in accordance with Rule 17.11 and Table 17-A.

17.25 Arrangements
Switchboards having no current carrying parts (dead front" boards) should be provided where practicable, particularly in theatres and similar places where rapid handling is necessary and attention must be given to signals.

17.26 Oil-filled Apparatus
Where practicable, equipment containing oil and mounted on switchboards should be separated from other kinds of equipment by non-inflammable barriers, or otherwise adequately isolated. Oil sills or other devices should be provided to retain escaping oil. Whenever located on balconies this should always be done. Drainage for escaping oil should be provided where practicable.

17.27 Grounding
Switchboard frames and non-current carrying metal parts should be permanently grounded under the following conditions:
(a) When operating at more than 150 volts to ground.
(b) When in hazardous locations.
(c) When operating at any voltage if accessible to unqualified persons and grounded surfaces are within reach (five feet horizontally and eight feet from the floor).

17.28 Guarding
(a) General: Switchboards operating at more than 300 volts to ground and located near passageways shall be protected by rails, barriers, or enclosures.
(b) Live Parts on the Front of the Board: Where parts on the front of the board are not guarded or isolated by elevation and subjected to more than 100 volts, the switchboard should be provided with insulating mats, floors or platforms so arranged that the operator cannot inadvertently touch such live parts without standing upon the mats, floors or platforms. Parts exceeding 150 volts to

ground should not be accessible to unqualified persons.

(c) Mats and Platforms should afford a non-slip and non-trip surface and should conform to the standards for such guards. Mats with beveled edges are preferable.

17.3 Oil Filled Apparatus

17.31 Oil Circuit Breakers

When located on floors of buildings or in galleries, oil circuit breakers should be separated from other apparatus by adequate non-inflammable barriers, or otherwise adequately isolated.

When located outdoors they should be adequately isolated.

17.32 Transformers, Induction Regulators

When in buildings these should preferably be located on lower floors or in basements. When this is not practicable, adequate provision should be made to prevent leakage on other apparatus. When the apparatus contains large quantities of oil, each unit or group should preferably be placed in a separate fireproof compartment suitably ventilated. Provisions should be made for quick and suitable drainage whether the apparatus is located in or outdoors.

Exception to these rules may be made where the transformer is equipped with dielectric cooling liquid which is non-inflammable and non-explosive.

When located outdoors the transformer should be adequately isolated in outdoor enclosures so arranged that unauthorized persons cannot come in contact with any part of the casing or wiring.

17.33 Current Transformers, Secondary Circuits

These, including constant-current and instrument transformers should be provided with means for short circuiting their secondaries ahead of all instruments or other devices so as to permit the removal of the latter without opening the secondary circuits.

17.4 Rotating Equipment

17.41 Hazardous Location

See 17.1

17.42 Grounding

See 17.1

17.43 Speed Limiting Devices

(a) Prime movers driving generating equipment should be provided with automatic speed limiting devices, in addition to their governors.

(b) Machines of the following types should be provided with speed limiting devices, unless their inherent characteristics, or the load and mechanical connection thereto are such as to safely limit the spped, or unless the machine is always under the manual control of a qualified operator:

1. Separately excited direct current motors
2. Series motors.

3. Motor generators and converters that can be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load.

17.44 Low Voltage Protection

All motors so employed or arranged that an unexpected starting of the motor is a hazard, except those with an emergency use, and where the opening of the circuit may cause a special hazard, such as exciter or condenser pump motors, shall be equipped with low voltage protection which will automatically cause and maintain the interruption of the motor circuit, when the voltage falls below a certain operating value. Motor-running protective devices consisting of circuit-breakers, controllers with over current units, thermal cutouts or other devices approved for the purpose should be required for each motor to protect the motor and motor branch-circuit conductors against operating overloads.

17.5 Storage Batteries

Rooms or enclosures containing storage batteries should be so ventilated as to remove acid spray and prevent dangerous accumulation of inflammable gas. Passage of such gases to other rooms should be prevented.

Switches and incandescent electric lamps in battery rooms should be of the vapor proof type.

17.6 Fuses, Circuit-Breakers, Switches and Controllers

All switches, fuses, automatic circuit breakers, starting rheostat, and other control devices should be so arranged or marked as to identify the equipment controlled by them. Circuit breakers should be so located and shielded that persons will not be burned or injured by their operation. Switches should be so installed as to minimize the danger of accidental operation. Switches which may tend to close by gravity should be provided with proper devices to prevent accidental closing.

Where practicable, the blades of knife switches should be dead when the switches are open.

Fuses should be so arranged that either:

(a) They are disconnected from all sources of electrical energy before they can be touched.

(b) They can be disconnected by a switch.

(c) They can be conveniently handled by means of suitable insulated tools provided for that purpose.

17.7 Electrical Wiring

Inside wiring should be rigidly installed, protected from mechanical injury and have ample current-carrying capacity for its intended use. All wiring should be effectively insulated and, where practicable, should be enclosed in a conduit or equivalent construction. Conductors should be protected against excessive heating by the design of the system, and by the installation of suitable fuses or automatic circuit breakers in all conductors except ground or

neutral conductors.
Conduits should be effectively grounded.
Oil switches and disconnectors should be so arranged that they can be secured in the open position or plainly tagged to prevent inadvertent closing while work is being done on equipment controlled by them.

17.8 Electrical Appliances (Portable Tools, Extension Lamps, Etc.)

17.81 Insulation
Portable devices should be provided with an adequate dielectric interposed between ungrounded current carrying parts and those external surfaces which persons can touch.

17.82 Grounding of Frames
The grounding of frames of portable devices operating at over 60 volts to ground is recommended as a safety measure.

17.83 Voltage Limits
Portable and pendant conductors shall not be installed or used on circuits operating at more than 300 volts to ground unless they are accessible only to qualified persons.

17.84 Hazardous Locations
Where exposed to dampness or corrosive influences, portable conductors shall be of a type specially suited and where exposed to inflammable gas or dust particles, they shall be so protected or isolated by elevation that they cannot be readily damaged. Portable lamps in locations where explosives or inflammable gases are present shall be incased in vapor-proof globes with suitable mechanical guards.
Portable lamps in damp places should be equipped with a socket of non-combustible, non-absorbent insulating material, an approved handle of non-absorbent insulating material, a basket guard, and approved cord.

17.85 Strain Relief
Portable and pendant conductors should be so installed that no strain is placed on the terminal connections and should have no joints except at suitable fittings.

17.9 Electrical Supply and Communication Lines

17.91 General Requirements
Design and Construction: Lines and equipment should be of suitable design and construction for the service and conditions under which they are to be operated.
Installation and Maintenance: Lines and equipment should be installed and maintained so as to reduce hazards to life as far as practicable.
Accessibility: Parts which must be examined or adjusted during operation shall be arranged so as to be readily accessible to authorized persons by the provision of adequate climbing space, working space, working facilities and clearances between conductors, in accordance with the National Electrical Safety Code.

17.92 Guarding

Current Carrying Parts: To promote safety to the general public and to employees not authorized to approach current carrying parts of electrical supply lines, such parts should be arranged so as to provide adequate clearance, or should be provided with guards so as to isolate them effectively from accidental contact by such persons.
Non-current Carrying Parts: Non-current carrying parts should be isolated and guarded or grounded.

17.93 Grounding
Metal conduits, cable sheaths, and frames, cases and hangers of equipment should be grounded.

17.94 Relative Levels
Supply and Communication Conductors: Where supply and communication conductors cross each other or are in conflict, or are located on the same poles or towers, the supply conductors should preferably be carried at the higher level.
Supply Lines of Different Voltages: Where supply conductors of different voltage cross each other or are in conflict, the higher voltage lines shall preferably be carried at the higher level.

17.95 Clearances
Horizontal Clearances of Supporting Structures from Other Objects (measured between the nearest parts of the objects concerned)

From Fire Hydrants:	Not less than three feet.
From Curbs:	Not less than six inches measured to the street side of the curb.
From Railroad Tracks:	Where railroad tracks are paralleled or crossed by overhead lines, the poles should if practicable be located not less than twelve feet from the nearest track rail.

Vertical Clearance of Wires above Ground or Rails
Basic Clearances: The clearances in Table 17-C apply under the following conditions:
(a) Temperature of 60° F., no wind.
(b) Span lengths o to 150 feet.
(c) Voltage o to 50,000 volts.
(d) Fixed conductor supports.
The vertical clearance of wires above ground or rails should be not less than shown in the following table.

TABLE 17-C--Minimum Vertical Clearance of Wires Above Ground or Rails
(All voltages are between wires unless otherwise stated)

Nature of ground or rails underneath wires	Guys; messengers; communication wires; grounded sheath cables. All voltages	Open Supply Line wires, arc wires and service drops			Trolley Contact conductors and associated wires	
		0 to 750 volts	750 to 15000 volts	15000 to 50000 volts	0-750 to ground	Exceeding 750 volts to ground
	WHERE WIRES CROSS OVER					
Tracks rails of railroads handling standard freight cars on top of which men are permitted	Feet 27	Feet 27	Feet 28	Feet 30	Feet 22	Feet 22
Tracks rails of railroads not included above and streets, alleys, or roads in urban or rural districts	18	18	20	22	18	20
Driveways to residence garages.	10	10	20	22	18	20
Spaces or ways accessible to pedestrians only	15	15	15	17	16	18
	WHERE WIRES RUN ALONG					
Streets or alleys in urban districts	18	18	20	22	18	20
Roads in rural districts	15	15	18	20	18	20

Increased Clearances

(a) For Spans Exceeding 150 Feet: The clearances in Table 17-C should be increased by 0.1 foot for each ten feet of the excess over 150 feet.

(b) For voltages Exceeding 50,000: The clearances given in Table 17-C should be increased at the rate of 0.5 inch for each 1000 volts of the excess.

Wire Crossing Clearances

Basic Clearances: The clearances given in Table 17-D to follow, apply under the following conditions:

(a) Temperature of 60° F. (no wind).

(b) Where the sum of the distances from the point of intersection of two crossing wires to the nearer supporting structure of each span does not exceed 100 feet.

(c) Where the upper conductor or wire has fixed supports. Conductors of lines operating at the voltages indicated at the heads of columns should, in general, be installed above those to the left of the table, where a clearance is marked thus*.

TABLE 17-D--Wire-Crossing Clearances

NATURE OF WIRES CROSSED OVER	Communication wires	Open supply wire 0 to 75 volts and grounded supply cables of all voltages		Open supply wires and service drops		Guys span wires lightning protection wires
		Line wires	Service drops	750 to 7500 volts	7500 to 50000 volts	
	Feet	Feet	Feet	Feet	Feet	Feet
Communication, including cables on messengers	2	4*	2*	4*	6*	2*
Supply cables having permanently grounded continuous metal sheath all voltages	4	2*	2*	2*	4*	2*
Open Supply wires:						
0 to 750 volts	4	2*	2*	2*	4*	2*
750 to 7500 volts	4	2	4	2*	4*	4*
7500 to 50000 volts	6	4	6	4	4*	4*
Trolley Contact Conductors	4*	4*	4*	6*	6*	4*
Guys, messengers, span wires, lightning, protection wires, service drops						
0 to 750 volts	2*	2*	2*	4*	4*	2*

Increased Clearances: Where the sum of the distances from the nearer supporting structure of each span to the point of intersection exceeds 100 feet, the clearances in Table 17-D should be increased by 0.1 foot for each ten feet of the excess over 100 feet.

For voltages exceeding 50,000 the clearances given in Table 17-D shall be increased at the rate of 0.5 inch for each 1000 volts of the excess.

Clearances from Buildings

Minimum clearance--Unguarded or accessible supply conductors carrying voltages in excess of 300 volts should not come closer to any building or its attachments than listed in Table 17-E.

TABLE 17-E

Clearances of Supply Conductors from Buildings--Spans 0 to 150 feet.

Voltage of Supply Conductors	Horizontal clearance	Vertical clearance
	Feet	Feet
300 to 7500	5	
7,500 to 15,000	8	
15,000 to 50,000	10	
Exceeding 50,000	10 plus 0.5 inch per K.V. in excess	10 plus 0.5 inch per K.V. in excess

Where span lengths exceed 150 feet the increase should be 0.1 foot for each ten feet of the excess over 100 feet.

Vertical Separations between Horizontal Crossarms

Crossarms supporting line conductors should be spaced in accordance with Table 17-F.

The separation given in Table 17-F is for crossarms carrying conductors of 0 to 50,000 volts attached to fixed supports.

TABLE 17-F
Vertical Separation of Cross Arms Carry Conductors

	Supply conductors; if possible at higher levels				
Conductors usually at lower levels	0 to 750 volts and permanently grounded continuous metal sheath cables of all voltages	750 to 7500 volts	7500 to 15000 volts	Same Utility	15,000 to 50,000 volts Different Utilities
Communication Conductors	Feet	Feet	Feet	Feet	Feet
General	4	4	6		6
Used in Operation of supply lines	2	2	4	4	6
Supply Conductors					
0 to 750 volts	2	2	4	4	6
750 to 7500 volts		2	4	4	6
7500 to 15000 volts		See note X	4	4	6
		See note Y	2	4	4
Exceeding 15000 volts but not exceeding 50,000 volts				4	4

Note "X"--If worked on alive with long handled tools, and adjacent circuits are neither killed nor covered with shields or projectors.

Note "Y"--If not worked on alive except when adjacent circuits are killed or covered by shields or protectors, or by the use of long handled tools not requiring line men to go between live wires.

Adequate climbing space should be maintained on poles. A horizontal climbing space of 30 inches is recommended for supply conductors of voltage less than 7500.

Poles should be properly guyed at all points of unusual stress, such as dead ends and curves. Guys should be so located or guarded where necessary as not to endanger or be endangered by traffic of any description. A guy insulator 8' to 10' above the ground should be placed in every guy to a pole or other structure carrying wires of more than 300 volts to ground.

18. Mechanical Power Transmission Equipment

18.1 Shafting

Each continuous line of shafting should be so secured in position as to prevent excessive endwise movement.

Shafting should run without excessive whipping or vibration.

All exposed parts of horizontal shafting six feet or less from the floor or work platform, except shafting in runways used only for oiling or running adjustments, should be

protected by a stationary casing enclosing the shafting completely or by a trough enclosing the sides and top or the sides and bottom of the shafting as location requires. Shafting under bench machines should be enclosed by a stationary casing or by a trough at the sides and top or the sides and bottom, as location requires. The sides of the trough should be carried to within not more than six inches of the underside of the table, or, if the shafting is located near the floor, to within six inches of the floor. In every case, the sides of the trough should extend at least two inches below or above the shafting, as the case may be. Vertical and inclined shafting six feet or less from the floor or work platform, except shafting in maintenance runways, should be enclosed by a stationary casing.

Exposed shaft ends should present smooth surfaces. They should not project more than one-half the diameter of the shaft beyond bearing or hub unless they are guarded by non-rotating caps or safety sleeves.

Key-ways not in use should be covered.

18.2 Pulleys

Every pulley should be guarded if any part of it is 6 feet or less from the floor or work platform.

Balance wheels (such as on punch presses), may be guarded by discs covering the spokes, unless they are belt-driven and the point of contact between the belt and wheel is less than 6 feet from the floor or platform. In the latter case, the wheels should be enclosed.

Cracked pulleys, or pulleys with broken rims, should not be used.

Pulleys which are permanently out of service should not be allowed to remain on shafting which is in use.

18.3 Belts, Ropes and Chains

Where both runs of a horizontal belt are six feet or less from the floor level, the guard should extend to at least 15 inches above the belt, except that where both runs of a horizontal belt are 42 inches or less from the floor, the belt should be fully enclosed.

Overhead horizontal belts, the lower parts of which are seven feet or less from the floor or platform, should be guarded for their entire length on the sides and bottom.

Overhead horizontal belts which are more than seven feet above the floor or platform should be guarded for their entire length under the following conditions:

If they are located over passageways or work places and travel 1800 feet or more per minute, and

If the center to center distance between pulleys is ten feet or more, and

If the belt is eight inches or more in width.

Where the upper and lower runs of horizontal belts are so located that passage of persons between them would be pos-

sible, the passage should be completely barred by a guard rail or other barrier, or, where the passage of persons is regarded as necessary, there should be a platform over the lower run, guarded on either side by a solid barrier or by a railing completely filled in with wire mesh or other filler. The upper run should then be so guarded as to prevent contact therewith by either a worker or objects carried by him.
If the guard or enclosure for a vertical or inclined belt is within four inches of the belt, it should be not less than six feet in height. Openings through the guard which are more than ½ inch in width, and through which fingers might be inserted and so be injured by belt and pulley, should be completely covered or protected by substantial material such as wire netting of not more than ½ inch mesh, made of wire not smaller than No. 16 U.S. Standard Guage.
If the guard for a vertical or inclined belt is more than four inches distant from the belt and pulley, it should be not less than five feet in height. Such guards, if constructed of wire mesh, should not have openings larger than two inches in size and the wire should be not less than No. 12, U.S. Standard Guage. Slatted guards, if used, should not have openings greater than one inch in width.
Guards for inclined belts should be so installed that the vertical clearance between the lower run of the belt and the floor, at any point outside of the guard, is not less than six feet six inches.
Vertical belts running over a pulley which is more than six feet above the floor or platform should be guarded at the bottom in the manner recommended for overhead horizontal belts, if they are located over passageways or work places and travel 1800 feet or more per minute, and if they are eight inches or more in width.
The preceding recommendations pertaining to belts also apply to ropes.
Overhead chain and link belt drives, where the chain exceeds two inches in width, should be guarded in accordance with the recommendations made for overhead horizontal belts.
Sprocket wheels and chains should be enclosed unless they are more than seven feet above the floor or platform.

18.4 Gears

Gears should be guarded by:
(a) a complete enclosure, or (b) a guard at least six feet high and extending at least six inches above the mesh point of the gears, or (c) by a band guard covering the face of the gear and having flanges extending inward beyond the roots of the teeth on the exposed side or sides.
Where any portion of a train of gears, guarded by a band guard, is less than six feet from the floor, a disc guard or a complete enclosure to the height of six feet should be installed.

It may not be absolutely essential to guard hand-operated gears which are used only to adjust machine parts and which move only when hand power is applied. However, the guarding of such gears is recommended.

18.5 Friction Drives

The driving point of a friction drive should be guarded if it would otherwise be exposed to contact.

Arm or spoke friction drives and web friction drives with holes in the web should be entirely enclosed.

Projecting bolts on friction drives should be guarded if they would otherwise be exposed to contact.

18.6 Keys and Set Screws

Keys, set screws and similar revolving parts should be made flush, should be countersunk, or should be guarded by metal covers. This may not apply to some keys or set screws which are wholly within gear casings, sprocket casings or similar enclosures.

18.7 Collars and Couplings

Revolving collars, including split collars, should be cylindrical. Screws or bolts in a collar should not project beyond the largest periphery of the collar.

Shaft couplings should be constructed so that their bolts, nuts, set screws or other revolving parts will not present a hazard. Bolts, nuts and set screws should be countersunk where that is possible. In any event, they should not extend beyond the flange of the couplings unless they are covered by safety sleeves.

18.8 Starting and Stopping Devices

To assist in preventing injuries, and to assist in limiting the severity of injuries when accidents do occur, it is highly important that there be means of controlling, and especially of stopping, the flow of power from an engine, turbine, motor or other prime mover to the transmission equipment and to the machines driven thereby. It must be remembered that most prime movers are so constructed that, once they are started, they tend to continue to drive the equipment mechanically connected to them at a nearly constant speed quite regardless of the relatively minor loads imposed by contact of the human body with power transmission equipment or with power-driven machines.

This section does not include recommendations with respect to starting or stopping devices controlling the prime mover itself. Such material is included in Section 15.

If any mechanical power transmission equipment or any power driven machine cannot be readily seen from the point at which the flow or power to it is controlled, effective signalling equipment should be installed and so used as to give ample warning that machinery is to be started.

To provide emergency control of power, transmission equipment should be divided into separate units and there should

be a clutch or equally effective device controlling the flow of power from the prime mover to each such unit. Preferably, no transmission unit from which machines are driven should extend beyond a single room. Clutches and other emergency control devices should be immediately accessible and should be so marked as to clearly indicate their purpose and how they should be operated.

It is recommended that the stopping of the supply of power to each unit of transmission equipment be subject to remote control in addition to control at the stopping device. Remote control stations should be in such number and so located that power can be shut off quickly by a person starting from any point within the room or area under consideration. The starting of the supply of power by remote control is not recommended.

Every power-driven machine not driven by an individual motor or prime mover should be equipped with a clutch, loose pulley or similar device for quickly disengaging power. The means for operating such a disengaging device should be so located and so arranged that the operator of a machine can readily reach it and use it from any working position. At the same time, the location and arrangement should be such as will reduce to a minimum the likelihood of accidental operation. A belt tightener is not recommended as a device for engaging and disengaging power.

Hand-operated or foot-operated internal clutches, such as those embodied in some guillotine cutters, power presses and embossing machines, are not disengaging devices within the meaning of this paragraph.

Each pair of tight and loose pulleys should be equipped with a permanent mechanical belt shifter. Each clutch or starting gear should be equipped with a permanent operating handle. It is preferable that belt shifter, clutch and gear handles be so arranged that they will hand or stand vertically when the belt is on the loose pulley or when the clutch or gear is disengaged.

In a given shop, all belt shifter, clutch or gear handles of the same type should move in one and the same direction to stop machines, i.e., all to the right or all to the left from the running position. This recommendation does not apply to those clutches, as on countershafts which embody two clutch pulleys carrying open and crossed belts respectively. In such a case, there are three positions for the clutch handle and the driven machine should be without power when the clutch handle is in the center (or neutral) position.

Every belt shifter should include mechanical means which will prevent the belt from creeping from the loose to the tight pulley.

The shifting part of jaw clutches, and the shifting or mechanism part of friction clutch couplings, should be

attached to the driven shaft, i.e., to the shaft which will be idle when the clutch is disengaged.
Clutches, cut-off couplings or clutch pulleys having projecting parts should be enclosed by stationary guards if they are seven feet or less above the floor or work platform.

18.9 General Recommendations for the Construction of Guards
It is intended that the guards called for in the preceding paragraphs of this section be constructed in accordance with the following general recommendations.
All metal should be free from burrs and sharp edges.
Guard frames should consist of angle iron or iron pipe securely fastened to the floor, the wall, the ceiling or the frame of the machine. The filling material attached to the frame should be expanded, perforated or solid sheet metal or wire mesh.
If the uprights used for supports are made of angle iron, the angles should be not smaller than 1 inch by 1 inch by 1/8 inch; if they are made of iron pipe, it should be of not less than 3/4 inch Iron Pipe Size. Other construction should be of equivalent minimum strength. The sizes of the uprights should increase above these minima according to the weight and size of the guard, its location with respect to aisles and the possibility of its being damaged by moving equipment.
Wire mesh should be of the type in which the wires are securely fastened at every cross point by welding, soldering or galvanizing, except in the case of diamond or square wire mesh made of No. 14 Guage Wire, 3/4 inch mesh or heavier.
The filling material (expanded metal, sheet metal, wire mesh, etc.) should be securely fastened to the supports. For angle iron supports, the fastening may be by means of 3/4 inch by 1/8 inch flat iron fastened to the angle by 5/16 inch bolts or rivets placed at intervals not exceeding ten inches, or by means of 1 inch by 1 inch wooden strips fastened to the angles by 5/16 inch bolts. For pipe supports, the fastening may consist of clamps or of heavy wire. Perforated or sheet metal may be bolted or riveted directly to the supports, or may be spot-welded thereto.

19. Moving Parts of Machines
This section relates to machines in general and to numerous parts of those machines which are in motion when the machines are in operation. It does not relate to point-of-operation hazards. It is followed by sections pertaining to specific machines and to the hazards peculiar to those machines.
All dangerous moving parts of machines, so located that any person may come in contact with them, should be guarded. Gears, sprockets, and set-screws or similar projections, wherever located, should be guarded if they are not completely encased by the housing of the machine.

All other dangerous moving parts located within six feet of the floor or work platform, if not protected by the housing of the machine, should be guarded unless they are so located with respect to walls, other equipment or other machines that they are as effectively protected as if they were guarded. Balconies or runways on machines are considered work platforms with respect to the guarding of machine parts near them.

Gears, sprockets and friction drives should be guarded as is outlined in Section 18, with the additional recommendation that, if a guard or enclosure is within four inches of the moving parts, any openings through the guard which are more than ½ inch in width should be completely covered or should be protected by substantial material such as wire netting with ½ inch or smaller mesh made of wire at least as heavy as No. 20 U.S. Standard Guage.

Belts and pulleys should be guarded as is outlined in Section 18, or should be completely enclosed. It may not be essential to guard flat belts, which are one inch or less in width or round belts which are ½ inch or less in diameter and which are not driving belts, except in industries in which women are employed and where such belts are so located that hair or clothing is likely to come in contact with them.

Wheels, shafting, spindles and other revolving or reciprocating parts should be guarded as is outlined in Section 18 hereof or should be completely enclosed. If a guard or enclosure is within four inches of the moving parts, any openings through the guard which are more than ½ inch in width should be completely covered or should be protected by substantial material such as wire netting with ½ inch or similar mesh made of wire at least as heavy as No. 20 U.S. Standard Guage.

Set screws, bolts, keys, oil cups and similar revolving projections, which are not enclosed by the housing of the machine, should be made flush, protected with cylindrical safety sleeves, or completely enclosed.

Guards for machine parts should be substantial, adequately supported and securely fastened. They may well be made in accordance with the general recommendations for the construction of guards which are included in Section 18.

20. Woodworking Machines

This section relates especially to the point-of-operation hazards presented by certain machines commonly used in woodworking. No attempt has been made to include all such machines and it must therefore be recognized that there are woodworking machines, not specifically mentioned in this section, which should be equipped with adequate point of operation guards so that the hazards will be reduced to a minimum.

It should also be recognized that this section considers

only point-of-operation hazards, in addition to saw speeds, and that there are sections of this Handbook which pertain to various other hazards commonly encountered in woodworking establishments.

20.1 Saw Speeds

Circular saws should not be operated at speeds in excess of those listed in the following table. For ordinary saws, the speeds given in Column A should not be exceeded. If high-speed saws are used, speeds not to exceed those given in Column B may be permitted if the saw manufacturer so recommends Saws for operation at high speeds should be understood to include only those made of alloy steel having an elastic limit not less than 150,000 pounds per square inch and specially tensioned to run smoothly at the speeds employed.

TABLE 20-A

Diameter of saw	Revolutions per Minute	
	A Saws for operation at ordinary speeds 15,000 F.P.M.	B Saws for operation at high speeds 18,000 F.P.M.
8-inch	7,200	9,000
10-inch	5,760	7,200
12-inch	4,800	6,000
14-inch	4,110	5,140
16-inch	3,600	4,500
18-inch	3,200	4,000
20-inch	2,880	3,600
22-inch	2,620	3,260
24-inch	2,400	3,000
26-inch	2,220	2,750
28-inch	2,060	2,570
30-inch	1,920	2,400
32-inch	1,800	2,250
34-inch	1,690	2,100
36-inch	1,600	2,000
40-inch	1,440	1,800
44-inch	1,310	1,640
48-inch	1,200	1,500
54-inch	1,070	1,330
60-inch	960	1,200

No band-saw wheel should run at a speed in excess of that which will allow a factor of safety of ten in all parts of the wheel. Each wheel and the frame of each machine should be marked by its manufacturer, in letters not less than one-quarter of an inch in height, stating the maximum allowable speed in revolutions per minute. Band-saw wheels

should be so manufactured and mounted that they will run true at their maximum speeds without excessive vibration.

20.2 Guards for Saws

20.21 Band Saws, Band Resaws and Band Knives

all portions of the blade should be enclosed or guarded except the working side of the blade below the guide rolls or gauge. The guard for the portion of the blade between the sliding guide and the upper sawwheel guard should be self-adjusting. Band-saw and band-knife wheels should be completely encased.

Feed rolls should be equipped with a guard which will prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard should be constructed of heavy material, preferably metal, should be adjustable to the size of the stock being cut and should be firmly secured to the frame of the machine.

20.22 Log Band Saws (Sawmill Type)

20.23 Circular Rip Saws (Manual Feed)

Each circular rip saw should be guarded by a hood which will cover the saw at all times to at least the depth of the teeth. The hood should adjust itself automatically to the thickness of, and should remain in contact with, the material being cut. The hood should be so constructed as to protect the operator from flying splinters and broken saw teeth.

Each saw should be equipped with a spreader, splitter or riving knife. It should also be equipped with a non-kickback device which will prevent material being thrown back on the operator.

20.24 Circular Cross Cut Saw and Circular Knives (Manual Feed)

Each circular cross cut saw or circular knife should be guarded by a hood which will cover the saw or knife at all times to at least the depth of the teeth or cutting edge. The hood should adjust itself automatically to the thickness of, and should remain in contact with, the material being cut. The hood should also be so constructed as to protect the operator from flying splinters and broken saw teeth.

20.25 Circular Rip Saws and Cross Cut Saws (Self Feed)

20.26 Circular Resaws

20.27 Swing Cut-off Saws

Each swing cut-off saw should be provided with a metal hood, so arranged that the part of the saw above the table is covered to at least the root of the teeth. This hood should be constructed in such a manner and of such material that it will afford the operator a view of the cutting edge of the saw at all times. The hood should adjust itself automatically to the thickness of, and remain in contact with, the material being cut. It should be so constructed as to protect the operator from flying splinters and broken saw teeth.

Each swing cut-off saw should be provided with an effective

device which will return the saw automatically to the back of the table when the saw is released at any point in its travel. Such a device should not depend for its proper functioning upon any rope, or spring. If the device includes a counterweight, provision should be made to prevent its falling. For instance, it should be bolted to the bar by means of a bolt passing through both bar and counterweight, or a bolt should be put through the extreme end of the bar. If the counterweight does not encircle the bar, a safety chain should be attached to it.

Limit chains or other equally effective devices should be provided to prevent the saw from swinging too far in either direction.

A latch may be provided to catch and return the saw at the rear of the table.

Where conditions are such that there is a possibility of contact with the saw from beneath or behind the saw table, the exhaust hood, or the guard if no exhaust hood is installed should be so arranged and maintained as to guard effectively that portion of the saw which is beneath or behind the saw table.

20.28 Gang Trim Saw and Gang Slasher (Sawmill Type)

20.29 Jump Saw or Bed Trimmer (Sawmill Type)

20.3 Guards for Miscellaneous Woodworking Machines

20.31 Boring and Mortising Machines

Safety bit chucks, with no projecting set screws, should be used. Universal joints on the spindles of boring machines should be enclosed.

An inverted iron stirrup should be fastened to the floor over the operating treadle, leaving only sufficient room for the operator's foot between treadle and stirrup.

If there is a counterweight, provision should be made to prevent its falling. For instance, it should be bolted to the bar by means of a bolt passing through both bar and counterweight, or a bolt should be put through the extreme end of the bar. If the counterweight does not encircle the bar, a safety chain should be attached to it.

20.32 Jointers

Hand-fed planers or jointers with horizontal heads should be equipped with cylindrical cutting heads. The throat of any such head should not exceed 7/16 inch in depth or 5/8 inch in width. It is recommended that cylinders be used in which the throat does not exceed 3/8 inch in depth or ½ inch in width.

Each hand-fed jointer with a horizontal cutting head should be equipped with an automatic adjustable guard which will cover the section of head next to the operator and with a guard which will cover the section of the head back of the gauge.

Each jointer with a vertical head should be equipped with a

guard, which may be an exhaust hood, so arranged as to completely enclose the revolving head, except for a slot of such width as may be necessary and convenient for the application of the material to be jointed.
Each stave or heading jointer should be equipped with an adjustable or automatic guard which covers all of the head except that portion where the stock is applied. Foot-power machines for jointing staves should be equipped with guards which prevent the operator's fingers from coming in contact with the knives.

20.33 Lathes

Automatic lathes of the rotating knife type, such as shoe last and spoke lathes, should be equipped with metal hoods or covers completely enclosing the cutter blades while the stock is being worked.
If such guards are made of sheet metal, the thickness of that metal should be not less than 1/16 inch. If the guards are made of cast iron, the thickness of that material should be not less than 3/16 inch. An exhaust hood may act as part of or all of the guard but, if it is so used, it should be of metal and the thickness of the metal should be not less than is recommended in this paragraph.

20.34 Planing, Molding, Sticking and Matching Machines

All cutting heads and saws on planing, molding, sticking and matching machines should be covered by metal guards. If such guards are made of sheet metal, the thickness of that metal should be not less than 1/16 inch. If the guards are made of cast iron, the thickness of that material should be not less than 3/16 inch. An exhaust hood may act as part of or all of the guard but, if it is so used, it should be of metal and the thickness of the metal should be not less than is recommended in this paragraph.
Feed rolls should preferably be completely enclosed, excepting only that portion which may be necessary to admit the stock. They may be guarded by a strip or bar fastened to the frame carrying the rolls and so arranged as to remain in adjustment for any thickness of stock. If the top roll is corrugated, the guard should be extended over the top of the roll.
Planers should be equipped with sectional feed rolls. A sectional finger device should be used in connection with solid feed rolls in order to prevent kick-backs.

20.35 Sanding Machines

Each drum sanding machine should be equipped with a guard, which may be an exhaust hood, so arranged as to enclose the revolving drum with the exception of such portion of the drum above the table as may be necessary and convenient for the application of the material to be finished. The feed rolls of a drum-feed sanding machine should be protected by a guard which will prevent the hands of the operator from

coming in contact with the in-running rolls at any point. The guard should be made of heavy material, preferably metal, should be adjustable to the size of stock being finished and should be firmly secured to the frame of the machine.

20.36 Shapers

Each cutting head on a shaper, hand-fed panel raiser, or other similar machine not automatically fed, should be enclosed by an adjustable guard cage or hood which will prevent the operator from coming in contact with the cutting head. In no case should a warning device of leather or other material attached to the spindle be acceptable in lieu of a guard.

Cylindrical heads should be used wherever the nature of the work will permit. The diameter of circular shaper guards should be not less than the greatest diameter of the cutter. All double spindle shapers should be equipped with a spindle starting and stopping device for each spindle.

20.37 Tenoning Machines

20.38 Universal Woodworking Machine

Each point of operation should be guarded as is recommended for individual machines of the type in question.

20.39 Wood Heel Turning Machine

21. Guards for Metal Working Machines

This section relates especially to the point-of-operation hazards presented by certain machines commonly used in metal working. No attempt has been made to include all such machines and it must therefore be recognized that there are metal working machines, not specifically mentioned in this section, which should be equipped with adequate point of operation guards so that the hazards will be reduced to a minimum.

It should also be recognized that this section considers, in the main, only point-of-operation hazards and that there are sections of this Handbook which pertain to various other hazards commonly encountered in metal working establishments.

21.1 Abrasive Wheels

The term "abrasive wheels," as herein used, refers to power-driven wheels consisting of abrasive particles held together by artificial or natural mineral or organic bonds. The term is not intended to include metal, wooden, cloth, or paper wheels or discs having a layer or layers of abrasive on the surface.

With the exception of wheels used for internal grinding and of wheels three inches or less in diameter running at peripheral speeds not exceeding 5000 feet per minute, every abrasive wheel should be equipped with one of the following devices:

(a) A protection hood, meaning an enclosure for the wheel consisting of a peripheral and two side members. Its

main function is to effectively retain the pieces of the wheel should it break in operation.

(b) Protection flanges, meaning flanges or safety collars used with abrasive wheels of special shape, so constructed that in addition to the usual function of clamping the wheel to the spindle they will also serve to effectively retain the pieces of the wheel should it break in operation.

(c) Protection bands, meaning continuous bands placed around cup, cylinder or sectional ring wheels to effectively retain the pieces of the wheel should one break in operation.

(d) A protection chuck, meaning a chuck used for mounting cup, cylinder or sectional ring wheels, so constructed that in addition to supporting and driving the wheel it will also serve to effectively retain the pieces of the wheel should one break in operation.

It should be noted that many cutting machines using solid abrasive cutting wheels should be equipped with auxiliary enclosures so arranged that they surround the working parts of the machines when the latter are in operation. Such auxiliary enclosures should be in addition to the protection hoods enclosing the wheels.

21.11 Protection Hoods

A protection hood should always be used with an abrasive wheel which is not equipped with protection flanges, bands or chuck.

Each hood should be so mounted as to maintain proper alignment with its wheel. The strength of the hood supports and fastenings should exceed the strength of the hood.

In general, the hood should enclose the spindle end, nut, and flange projections. However, protection hoods on cylindrical grinding machines, in all operations where the work provides a suitable measure of protection to the operator, may be so constructed that the spindle end, nut and flange are exposed. Where the nature of the work is such as to entirely cover the side of the wheel, the side covers of the guard may be omitted.

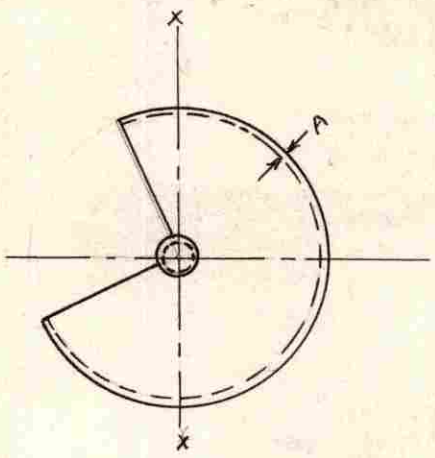
Hoods should be so constructed that it is not necessary, when changing wheels, to detach the peripheral protecting member from the side member which is connected to the machine.

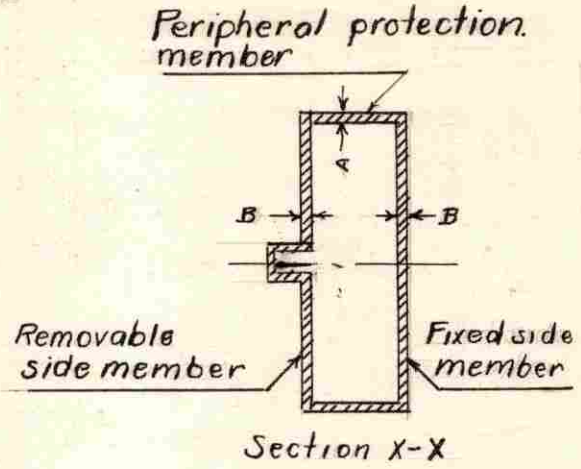
Hoods on machines used for dry grinding and for other dust-producing operations should be properly connected to an adequate exhaust system.

Protection hoods should be made of the materials recommended in Table 21-A, which provides for various wheel speeds, wheel thicknesses and wheel diameters. The thickness of peripheral hood members or of side members should be not less than is specified in that table.

For wheels running up to 7000 peripheral feet per minute, hoods may be made of any material listed in Table 21-A.

TABLE 21-A





Material Used in Construction of Guard		Max. Thick. of Grinding Wheel	GRINDING WHEEL DIAMETERS: 3 to 6 In. A	3 to 6 In. B	7 to 12 In. A	7 to 12 In. B	13 to 16 In. A	13 to 16 In. B
		Inches	Inches		Inches		Inches	
Mat'ls. satisfactory for speeds up to 7,000 per min.	Cast Iron	2	1/4	1/4	3/8	5/16	1/4	3/8
		4	5/16	5/16	3/8	5/16	1/4	3/8
		6	3/8	5/16	1/2	7/16	5/8	1/2
	Malleable Iron	2	1/4	1/4	3/8	5/16	1/4	3/8
		4	5/16	5/16	3/8	5/16	1/4	3/8
		6	3/8	5/16	3/8	5/16	5/8	1/2
Mat'ls. satisfactory for speeds up to 10,000 ft. per min.	Steel Castings	2	1/4	1/4	1/4	1/4	3/8	3/8
		4	1/4	1/4	1/4	1/4	3/8	3/8
		6	3/8	1/4	3/8	1/4	1/2	3/8
	Structural Steel	2	1/8	1/16	3/16	1/8	3/16	3/16
		4	1/8	1/16	3/16	1/8	3/16	3/16
		6	3/16	1/16	1/4	1/8	1/4	3/16
	Wrought Iron	2	1/8	1/16	3/16	1/8	1/4	3/16
		4	1/8	1/16	1/4	1/8	1/4	3/16
		6	3/16	1/16	1/4	1/8	5/16	3/16

Material Used in Construction of Guard		Max. Thick. of Cutting Wheel	CUTTING WHEEL DIAMETERS: 12 to 16 In. A	12 to 16 In. B	17 to 20 In. A	17 to 20 In. B	21 to 24 In. A	21 to 24 In. B
Cutting wheels 14,000 s.f.p.m.	Structural Steel	1/8 and less	1/8	1/8	1/8	1/8	3/16	1/8

*A and B indicate thicknesses as indicated on sketch.

The thickness of the hood members should be not less than that specified for the material used.
Cast steel hoods or hoods fabricated from structural steel, wrought iron, or steel castings should be used with wheels running between 7,000 and 10,000 peripheral feet per minute. Exceptions may be made in the case of cutting wheels. For such wheels of diameters not greater than 16 inches, cast hoods made according to Table 21-A may be used for speeds up to 16,000 p.f.p.m. For cutting wheels of diameters greater than 16 inches, fabricated hoods made in accordance with the last line of Table 21-A should be used.

21.12 Wheel Exposures
The maximum angular exposure of the grinding wheel periphery and sides for hoods used on machines known as bench and floor stands should not exceed 90 degrees or one-fourth of the periphery. This exposure should begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle. See Fig. 36.

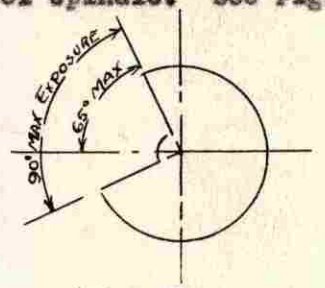


Fig. 36

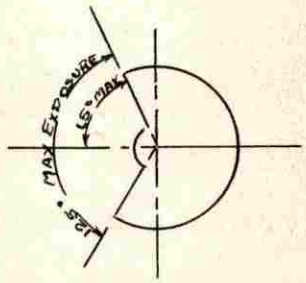


Fig. 37

Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure should not exceed 125 degrees. This exposure should begin at a point not more than 65 degrees above and extend to a point not more than 60 degrees below, the horizontal plane of the wheel spindle. See Fig. 37.
The maximum angular exposure of the grinding wheel periphery and sides for hoods used on cylindrical grinding machines should not exceed 180 degrees. This exposure should begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle. See Fig. 38.

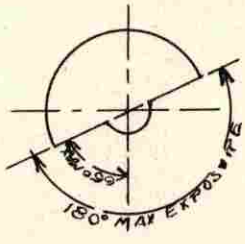


Fig. 38

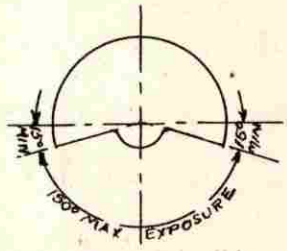


Fig. 39

The maximum angular exposure of the grinding wheel periphand sides for hoods used on cutting machines and on surface grinding machines which employ the wheel periphery should not exceed 150 degrees. See Fig. 39. This exposure should begin at a point not less than 15 degrees below the horizontal plane of the wheel spindle.
The maximum angular exposure of the grinding wheel periphery and sides for hoods used on cutting machines known as swing frame and portable grinding machines should not exceed 180 degrees, and the top half of the wheel should be protected at all times. See Fig. 40.

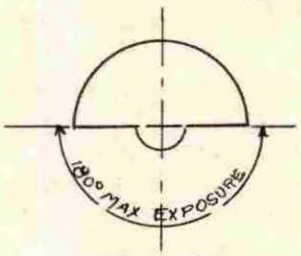


Fig. 40

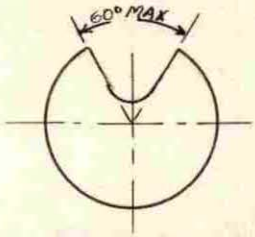


Fig. 41

In operations where the work is ground on the top of the wheel, the exposure of the grinding wheel periphery should be as small as practicable, with a maximum exposure of 60 degrees. See Fig. 41.
Hoods should be so constructed that the peripheral protecting member can be adjusted to the constantly decreasing diameter of the wheel by means of an adjustable tongue or its equivalent, so that the angular protection specified in the foregoing rules will be maintained throughout the life of the wheel, and so that the maximum distance between the wheel periphery and the tongue or end of the peripheral band at the top of the opening will not exceed ¼ inch. See Figs. 42, 43, and 44.

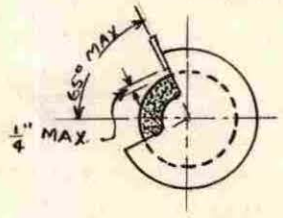


Fig. 42--CORRECT Showing adjustable tongue giving required angular protection for all sizes of wheels used.

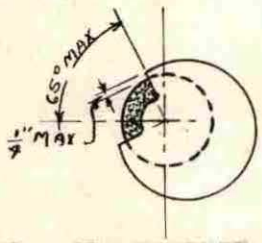


Fig. 43--CORRECT Showing movable hood with opening small enough to give required protection for smallest size wheel used.

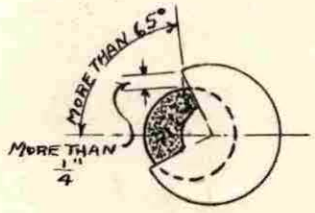


Fig. 44--INCORRECT Showing movable hood with size of opening correct for full size wheel, but too large for smaller wheels.

21.13 Flanges and Protection Flanges.
All abrasive wheels should be mounted between flanges, except those wheels which are mounted in chucks, cemented to metal back or otherwise securely and adequately mounted on spindles. In general, flanges may be of the straight type or of the tapered type. So-called straight flanges, adaptor flanges and sleeve flanges, for use with straight-sided wheels, are not protection flanges and should be used only in connection with protection hoods.
Protection flanges should be used with wheels which are not equipped with hoods, bands or chucks. The tapered type should be used wherever possible.

21.14 Protection Bands.
Protection bands should be used with cup, cylinder, and sectional ring wheels which are not protected by hoods or enclosed in protection chucks. The bands should be made of wrought iron, steel plate or their equivalent, should be continuous and should be bent to conform closely to the periphery of the wheel. The ends should be so riveted, bolted or welded together as to leave the inside of the band free from projections.
The thickness of the band should be not less than 1/16th inch for wheels under eight inches in diameter, not less than 1/8th inch for those 8 to 24 inches in diameter and not less than ¼th inch for those 24 to 30 inches in diameter.
The bands should be of such width that not more than one-quarter of the original height of a wheel protrudes beyond the protection provided. For wheels less than two inches thick, the maximum distance which the wheel may protrude should not be greater than the thickness of the rim. If the thickness of the rim is two inches or more, the wheel should not protrude more than two inches.

21.15 Protection Chucks
Where the chuck which holds the wheel is the only protection provided, it should be so constructed that the jaws will at all times protect the wheel up to the point herein recommended for protection bands.

21.2 Hammers
A drop or trip hammer should be equipped with a sweep motion device which will prevent the operator's hand from being between the punch and the anvil while the plunger is in motion, or it should be equipped with some other device which will as effectively produce that result. Some of the recommendations made in Item 21.3 hereof (Presses) are also applicable to hammers.

21.3 Presses

The machines included in this group may be divided into two general classes--one consisting of power presses and the other consisting of foot or hand presses.

The "power press" class includes power-driven machines fitted with plungers and dies and used for cold blanking, trimming, drawing, punching, stamping, forming or assembling material. The recommendations herein made for this class may apply to hammers so used as well as to presses, but are not intended to apply primarily to spring-actuated hammers, hot metal presses or hot metal hammers.

The "foot or hand press" class includes similar machines which are not power-driven, but are actuated only by foot or hand. The recommendations herein made for this class may also apply to drop hammers which are operated by a rope or belt passing over a power-driven shaft or pulley and in which the manual effort of the operator in lifting the hammer or weight is supplemented by the power of the shaft or pulley.

For a press of any type, the die setter should lock the starting device or otherwise make the press inoperative before setting up or removing dies.

When a die setter has set up or adjusted a press, and before the press is turned over to its operator, the die setter should replace in proper adjustment all guards which he removed or put out of proper adjustment in the course of his work on that press.

21.31 Power Presses

There are numerous ways in which the hazards of power press operation may be reduced. Some of those ways are considered to be more effective than others. The following recommendations have therefore been divided into three groups, those considered most desirable being in the first group, those considered relatively less effective being in the second group, and so on.

Any power press not equipped with a fully automatic feed should be equipped with a non-repeat device meaning an arrangement which disconnects the treadle or lever (if hand-operated) from the clutch mechanism after each stroke, or a device that will, within its own action, automatically lock the clutch mechanism into place so that the press cannot make a second stroke until the treadle or hand lever is again pressed to its lowest position, unless the arrangement is such that the guard remains in its protective position during the second stroke of the press.

21.311 Group 1. One of the following devices or arrangements should be in effect on each press:

(a) There should be a fully automatic feed of such a character that the services of an operator are required only at intervals and then only to restock the feeding device or magazine.

(b) There should be a guarded semi-automatic or mechanical feed, meaning a dial feed, slide feed, push feed, rotating feed or other similar device actuated by or attached to the machine, by means of which stock is fed under the plunger without it being necessary for the operator to place it there, and which includes a guard, enclosure or barrier in front of the plunger.

(c) The press should be so constructed that the distance traveled by the plunger is not more than 3/8 inch.

(d) For hand feed, there should be a fixed guard or enclosure entirely surrounding the plunger and so arranged that a finger cannot go under or over it and be injured by the plunger.

21.312 Group 2. One of the following devices or arrangements should be in effect on each press:

(a) There should be a semi-automatic or mechanical feed, meaning a dial feed, slide feed, push feed, rotating feed or other similar device actuated by or attached to the machine, by means of which stock is fed under the plunger without it being necessary for the operator to place it there.

(b) There should be a gate guard, meaning a guard or gate operated by the tripping device of the press, which interposes a barrier in front of the plunger before the latter descends, and which will not permit the press to operate until the hand of the operator has been removed to a safe distance from the plunger.

(c) There should be a sweep guard, meaning a device, mechanically operated by the press, which pushes the operator's hands out of the way of the plunger as the latter descends.

(d) There should be a two-hand device, meaning an arrangement whereby hands, instead of feet, are used to trip the press and whereby the tripping of the press requires the simultaneous action of the operator's two hands at points outside of the zone of danger.

(e) There should be an arm-operated guard, meaning a device actuated by the operator's arm in feeding the press and so arranged as to prevent the operation of the clutch mechanism while the hand is placing or removing stock.

(f) There should be a fixed guard or enclosure across the front and along both sides of the plunger, so arranged that a finger cannot go under or over it and be injured by the plunger while stock is being fed.

(g) There should be a mechanical device with attachments to the operator's wrists which will not permit operator's hands to be in the danger zone while ram is in lower position.

21.313 Group 3. One of the following devices or arrangements should be in effect on each press:

(a) There should be a fixed guard or enclosure across the front of the plunger, so arranged that a finger cannot go under or over it and be injured while stock is being fed.
(b) There should be a one-hand device, meaning an arrangement whereby the tripping mechanism of the press is controlled by one of the operator's hands acting at a point outside the zone of danger.
(c) There should be vacuum pick-ups or other effective hand tools for placing stock under the plunger such that the operator need not bring his hands within three inches of the plunger while feeding the press.

21.32 Foot or Hand Presses

There are similarly numerous ways in which the hazards of operating presses of this class may be reduced and, as is the case with power presses, some of those ways are considered to be more effective than others. The following recommendations have therefore been divided into two groups, those considered most desirable being in the first group and those considered relatively less effective being in the second group.

21.321 Group 1. One of the following devices or arrangements should be in effect on each press:
(a) An automatic feed as defined in Paragraph 21.311 (a) hereof.
(b) A limited plunger travel as defined in Paragraph 21.311 (c) hereof.
(c) A gate guard as defined in Paragraph 21.312 (b) hereof.
(d) A sweep guard as defined in Paragraph 21.312 (c) hereof.
(e) A two hand device as defined in Paragraph 21.312 (d) hereof.
(f) A fixed guard as defined in Paragraph 21.312 (f) hereof.

21.322 Group 2. One of the following devices or arrangements should be in effect on each press:
(a) A fixed guard as defined in Paragraph 21.313 (a) hereof.
(b) Hand tools as defined in Paragraph 21.313 (c) hereof.
(c) There should be automatic ejection of stock by means of a device for removing stock, such as an automatic pickoff, air blast or similar device which does not necessitate the operator placing his hands underneath the plunger in removing stock.

21.4 Punches

A plate or sheet metal punch should be equipped with a device which will prevent fingers from coming between the punch and the die.

21.5 Rolls

The inrunning side of the rolls such as are used for corru-

gating, crimping, embossing, printing or graining metal should be protected by a guard so arranged that material can be fed to the rolls without permitting the fingers of the operator to be caught between the rolls or between the guard and the rolls.

21.6 Saws

Circular saws having well-defined teeth, and especially high-speed saws of that type, should be equipped with hoods which, in each case, will cover the saw at all times to at least the depth of the teeth. It may not be essential to thus guard low-speed saws, saws used on hot work, or friction saws.

21.7 Shears

For shears driven by mechanical power or by foot or hand power, a guard or device should be in use which will prevent the hands of the operator from entering the zone travelled by the knives of the shears while the knives are in motion. This may be a fixed barrier, a gate or a sweep motion device or it may consist of a non-repeat device plus a starting device requiring the simultaneous use of the operator's two hands at points outside of the zone of danger.

21.8 Miscellaneous Machines

21.81 Milling Machines

The cutters on every milling machine should be shielded by a guard which provides a positive protection for the operator's hands.

21.82 Planers

The planer bed should be equipped with covers which will prevent injury by shear between the carriage and the planer bed. The clearance at each end of the planer should be at least three feet when the carriage is at the end of its travel.

21.83 Stranding Machines

21.84 Tumblers

21.85 Wire Drawing Machines

21.86 Extractors

22. Guards for Paper and Printing Machines

This section relates especially to the point-of-operation hazards presented by certain machines commonly used in the manufacture of paper and paper products and in printing on paper. No attempt has been made to include all such machines and it must therefore be recognized that there are paper and printing machines, not specifically mentioned in this section, which could be equipped with adequate guards so that the hazards due to their points of operation will be reduced to a minimum.

It should also be recognized that this section considers only point-of-operation hazards and that there are other sections of this Handbook which pertain to various other hazards commonly encountered in paper and printing

establishments.

22.1 Rolls

22.11 Calender and Similar Rolls

Each calender should be equipped with a guard or feeding device so arranged that material can be fed without permitting the fingers of the operator to be caught by the rolls. The device should be so arranged that the operator can immediately stop the rolls, at the feed point, by means of a lever, rod or treadle, or the rolls should be equipped with an automatic device which will stop them when the fingers approach the intake points.

The so-called "Doctor Feed" can be used on calender stacks. It is a device employed to keep the rolls clean and to assist in feeding the material into the inrunning side of each pair of rolls on the stack. It generally consists of a curved steel plate for each pair of rolls, extending their whole length, with its concave side toward the rolls and its top edge held by spring or gravity pressure against the surface of the top roll of each pair just above the nip on the outrunning side.

In operation, the material is fed into the top or first pair of rolls of the stack and, as it emerges, it is guided by the curved "Doctor Feed" plate into the next pair of inrunning rolls and so on down the stack.

22.12 Corrugating and Similar Rolls

22.13 Drum Winders

22.2 Cutters and Creasers

22.21 Each guillotine paper cutter driven by mechanical power should be equipped with a guard or device which will prevent the hands of the operator from entering the zone travelled by the knife while the knife is in motion. This may be a fixed barrier, a gate or a sweep motion device or it may consist of a non-repeat device plus a starting device requiring the simultaneous use of the operator's two hands at points outside of the zone of danger.

Each guillotine cutter driven by hand or foot power should be equipped with a rod or plate so arranged on the feeding side that the hand feeding the paper cannot reach the cutting edge while holding the paper in place and while feeding the paper.

22.22 Rotary Cutters and Slitters

22.23 Corner Cutters (With or Without Mechanical Power)

Each machine should be equipped with an adjustable guard which will make it impossible to place a finger underneath the knife while feeding stock. This guard should be adjusted to compensate for variations in the thickness of stock to be cut.

22.24 Creasers

Each rotary creaser or scorer should be equipped with an adjustable guard which will make it impossible to place a

finger underneath the disc while feeding stock. This guard should be adjusted to compensate for variations in the thickness of stock to be creased.
Platen type creasers and scorers should be guarded as is recommended for job platen presses in Paragraph 22.6 hereof.

22.3 Punches and Line Perforators (With Mechanical or Foot Power)
On each such machine, a device should be in use which will prevent fingers from coming between the punch and the die.

22.4 Paper Box Ending Machines

22.5 Corner Stayers (With or Without Mechanical Power)

22.6 Job Platen Presses (With or Without Mechanical Power)
One of the following devices or arrangements should be in effect on each press:
(a) There should be an automatic feed which makes it unnecessary for the operator's hands to be placed between the platen and the bed.
(b) There should be an automatic stop which will prevent the platen from closing if the hands are between it and the bed.
(c) There should be a gate guard or a sweep guard which will push the operator's hands out of the way as the press closes. If of the type which lifts the hands out of the danger zone, the guard should rise at least four inches above the platen as the press closes and should descend by gravity or be drawn by springs to eliminate the danger of shear between the guard and the top of the platen.

23. Guards for Leather Working Machines

24. Guards for Textile and Laundry Machines

25. Guards for Machines in the Food Industry

26. Guards for Rubber Working and Similar Machines

27. Hand Tools
The materials from which hand tools are made should be of good quality and each should be appropriate for the particular use to which it will be put.
Only tools made of non-sparking materials should be used where explosive gases or flammable materials are present.
Tools should be tempered, dressed and repaired only by persons qualified to perform such operations.
Tools which are not in use should be stored safely on racks or on shelves designed for them, or should be placed in tool boxes.
Tools should be inspected frequently by tool room attendants or other officially designated competent persons, and should be immediately removed from service if found to be defective. Common defects are, mushroomed heads and cracked or chipped points of cold chisels, splintered hammer handles, chipped hammer heads, splintered axe, pick or

sledge handles, and loose heads of hammers and axes.
Files should not be used unless they are equipped with adequate handles in good condition.
All cutting tools should be kept sharp.
Knives and sharpening steels should be equipped with disc or similar guards which will prevent the hand from slipping against the blade.
The cutting edges and sharp points of tools which are being carried should be guarded by sheaths or by devices affording equivalent protection.
Proper precautions should be taken to prevent tools from falling off of scaffolds, ladders or other elevations.
Tools should not be left lying, even temporarily, on stairways or in passageways.

28. Exhaust

In the absence of data, expressed in terms of basic engineering specifications, the principal guide to design of exhaust systems remains personal experience, and design of any individual system should, therefore, be entrusted to no one other than an engineer experienced in this class of work. The following paragraphs may, however, be of aid in attacking exhaust problems.

28.1 Exhaust Hoods

28.11 Dispersion of Atmospheric Impurities

Distinction should be drawn between the production of dusts, fumes, mists, vapors and gases and their dispersion into the atmosphere. Such substances are often produced without contamination of the atmosphere; on the other hand, solid dusts and fumes are frequently dispersed from areas where they are not produced.
The dispersion of contaminating material into the atmosphere requires energy, which is supplied in the following ways:

(a) Solid and Liquid Particles

If they are large enough and are thrown off with sufficient velocity, they will be dispersed by the kinetic energy of their own motion, i.e., by dynamic projection. The energy supplied in this way varies with the size and specific gravity and the initial velocity of the particles.
Microscopic particles cannot be dispersed any distance by virtue of their own kinetic energy because of their relatively great air resistance and small weight.
Microscopic particles are dispersed primarily by the movement of the air in which they are suspended.

(b) Vapors and Gases

The maximum velocity of diffusion does not exceed one f.p.m. and is therefore an unimportant dispersing force.
Vapors and gases lighter or heavier-than-air rise or fall from their source but the velocity of escape is not high unless there is a considerable difference in density.

Heavy gases may collect in pools or pockets of high concentration unless particular attention is paid to the question of air stagnation.

Vapors and gases escaping into the atmosphere at approximately the same density as the room air are dispersed primarily by air movement.

In order to prevent the dispersion of atmospheric impurities it is necessary to destroy or otherwise control the energy of dispersion--which means, in most cases, the control of air motion. The primary purpose of the exhaust hood, therefore, is to collect contaminated air rather than to remove the contaminating material from the air. This concept is important because it directs attention at once to the primary point of attack, namely, the source of air motion.

28.12 Control of Air Motion

The problem is two-fold: First, eliminate or reduce the velocity of air currents, wherever possible, around hazardous processes by eliminating or otherwise controlling the sources of air motion; second, air motion which cannot be eliminated must be brought under control, i.e., made to flow into the exhaust hood.

Sources of air motion around industrial processes and operations may be classified into four major groups: (a) Motion or energy fundamental to the machine or process itself. Examples: fan-action of a rotating wheel, escape of air from containers as they are filled, convection currents and air expansion over heated surfaces such as molten metal, etc., vibration of screens. (b) Forces incidental to the operation of the machine or process. Examples: air escaping past worn pistons in pneumatic tools or from badly placed exhaust ports, vibration of machinery. (c) Drag of air by large particles dynamically projected from their sources. Example: the drag of the stream of sparks thrown off tangentially from a grinding wheel creates an air current in the same direction which, in turn, disperses fine dust. (d) Miscellaneous external forces. Example: natural forces, such as convection currents, motion due to open conveyors and operation of nearby machinery.

Before the actual design of an exhaust hood is completed it is essential to determine the nature, magnitude and direction of action of dispersing air currents and to eliminate these insofar as possible by simple direct means, such as:

(a) Slight alteration in the design or operation of the process. Examples: changing location of exhaust port on pneumatic tools, prohibiting the use of an air blast to blow dust off casting in a foundry.

(b) Removal of external sources of air motion or shielding hazardous processes from them. Example: enclose nearby belts, elevators, etc.; control natural convection currents.

(c) Preventing the machine or process itself from creating undesirable air motion, by the application of suitable baffles and housings. Such enclosures should be designed to serve one of two purposes: (1) to utilize the motion of the machine to produce air currents toward the exhaust hood or (2) to prevent the development of air motion by the machine. Examples: utilizing the fan-action of a grinding wheel for the collection of its own dust; enclosing a reciprocating tool as closely as possible to reduce the pulsating air currents away from the tool; providing a suitable vent for the safe escape of air from mixers, bags, bins or other containers as they are filled with powdered material or volatile liquids.

(d) Causing large particles, which are dynamically projected along a well-defined path, to travel directly into an exhaust hood. If this is not possible, provide baffles against which the large particles will impinge, thus destroying their motion and with it the air drag which causes the dispersion of minute particles.

(e) Eliminating the vibration of machinery by means of suitable foundations, proper machine design, etc.

It is impossible to eliminate all air motion by these direct means alone but such measures are of great practical value. In general, more can be done in this way to reduce the required size and capacity of the exhaust system and the cost of operation than can be accomplished by the most elaborate method of hood design.

28.13 Hood Design

Object: To capture the contaminated air by means of airflow established toward and within the hood and to deliver this into the exhaust piping. Two basic factors are: the air velocities created in the zone of hood influence and the total rate of airflow into the hood. The air velocity toward the hood must be great enough to counteract the outward velocity of contaminated air; this condition should be obtained with the least possible total rate of airflow. The air velocity which must be developed in the zone of hood influence is determined by the force of dispersion of the contaminating material which arises primarily in the air motion generated around the machine or process. The magnitude and direction of air motion depends upon many factors which are not subject to exact evaluation.

Data for hood design may be collected in three ways:

(a) By measurement of actual air velocities generated by exhaust hoods now operating with known high efficiency.

(b) By direct experiment with full-scale model hoods. The process is isolated from other sources of contamination and the rate of airflow through the hood is varied until satisfactory conditions are obtained, as determined by quantitative analysis.

(c) In the case of visible ducts and fumes it is possible to determine visually the velocity necessary to turn the contaminated air at various points in the zone of production, into a small portable testing hood by noting the distance from the hood when this occurs. Knowing the flow characteristics of the testing hood and the total rate of airflow into it one can quickly calculate the air velocity at the point in question.

Note: The extra expense involved in the experimental determination of air velocity requirements will generally pay for itself through the more efficient exhaust system thus secured.

Static suction does not constitute a basic specification for hood design and should be abandoned in design. It is of value, however, as a simple index for routine measurement of operation.

28.2 Exhaust Piping

28.21 Purpose

(a) To connect exhaust hoods to a central source of suction.

(b) To insure proper distribution of flow from various hoods.

(c) To insure adequate air velocity for the pneumatic transport of the collected material to a central air-cleaning plant and point of discharge.

28.22 Transporting Velocity

Vapors and gases mix intimately with the air and may be moved as air may at any convenient velocity, which is determined by economy of pipe sizes and power consumption. Solid particles require certain minimum air velocities for pneumatic transport which vary with the size, shape and density of the material. The required velocity is higher for vertical lift than for horizontal movement.

28.23 A chip trap installed in the exhaust pipe close to the hood serves to reduce the required transporting air velocity by causing the removal of large particles at this point and also collects foreign bodies dropped into the hood, thus preventing blocking of the exhaust pipe. Chip traps are commonly designed with a cross-sectional area eight times the pipe area. The pressure-loss imposed by a chip trap should not exceed the reduction in pressure-loss in the pipe line made possible by the lower transporting air velocity.

Note: An objection to the use of chip traps lies in the fact that the collected material is not brought to a single central point. Chip traps require frequent dumping; automatic traps which open when the exhaust fan is shut down are not recommended.

28.24 Allowance for Future Expansion

No additions should be made to an existing exhaust system which throw the distribution of flow out of balance by

more than 25 per cent of the estimated requirements.
New connections are best made to the main exhaust pipe, as near as possible to the cleaning-plant or fan.
In certain cases, notably when expansion is contemplated very soon, it may be desirable to design the piping and fan for the ultimate system, only the needed part of which is built, and to provide orifices in the ends of the blanked-off pipe of sufficient capacity to admit enough air to maintain the required velocity of transportation.
The most satisfactory way to provide additional exhaust ventilation is by means of a new independent system.

28.3 Air-Cleaning Plant

28.31 Purpose: Air-cleaning is required for several reasons: (1) to prevent the creation of a nuisance or hazard in the area around the outlet; (2) to prevent the recontamination of plant air from the outside; (3) to permit recirculation of air discharged from the exhaust system in the plant.

28.32 Air-cleaning requirements vary with local conditions. The most rigid requirements must be met when the air is completely recirculated and the practice of returning the air to the plant should not be permitted except under the most favorable conditions. Minimum air-cleaning requirements apply to the isolated plant from which the exhaust air can be discharged without danger of recontaminating the plant. The concentration of polluting material in the discharged air should not be high enough to create a hazard in the discharge area.

28.33 Operating characteristics of the air-cleaning equipment should be such as to give steady and continuous operation during a practical working period. There should be no serious change in efficiency with use.
Storage capacity for the collected material should be sufficient to permit continuous operation over a practical period of time (at least one-half working shift) without shutting down for cleaning.
Means should be provided for the disposal of the collected material without exposing the workmen to a hazard.
Inspection and repairs to all harmful dry dust disposal apparatus should be made only by workmen provided with approved respirators.

28.34 The simplest means of disposal of contaminated air is through a high stack. Dilution with clean air and dispersion by favorable wind currents are depended upon to reduce the concentration to a safe level. Even in fully isolated locations the discharge stack is of questionable value and should be employed only as a last resort.
The nature and concentration of the escaping material and local meteorological conditions such as down-draft winds and eddies around buildings must be carefully considered

since these determine the practicability of this method of disposal.

Particles large enough to settle out at once must be removed before discharging the air into the stack.

28.35 Primary Dust Separators

Gravitational settling chambers, cyclones and inertial separation serve to remove relatively large particles of dust but cannot be depended upon to capture minute particles of hygienic interest.

Primary dust separation serves two purposes:

To prevent the development of a nuisance from settling dust in the discharge area and to reduce the load of dust on the filters.

Useful materials are often salvaged in a primary chamber.

Properly designed cloth dust-filters, when not overloaded, are capable of reducing the dust concentration in the filtered air to a level well within the safe limits of dustiness.

Important factors of design are the nature and size of the dust, the dust load per cubic foot of air and the rate of airflow. The most common filtering velocity is three f.p.m. although there is wide variation in practice.

Gases and vapors are separated from air by physical absorption, condensation, washing, chemical combination; the proper treatment must be determined in each case.

28.4 Source of Suction

28.41 Fan and motor capacity is determined by the total rate of airflow and overall resistance of the system.

Total rate of airflow equals the sum of the rates for the various hoods plus 10% for leakage.

Total pressure-loss equals the sum of the losses due to (1) static suction at the throat of the hood; (2) most resistant branch pipe, including bends and entrance into main; (3) main exhaust pipe; (4) air-cleaning plant, including entrance, passage through and discharge into pipe again; (5) exhaust pipe from cleaning plant to fan and on discharge side of fan.

28.42 Adequate provisions must be made for the entrance of air into the building to replace that removed by the exhaust system. Inlets should be so arranged and located that the workers are not subjected to a draft of air having a temperature more than 10° F. below the general room temperature or a velocity of more than 250 f.p.m.

Note: Inlets close to the ceiling with upward deflectors give best results.

28.43 The characteristics of the exhaust fan should be such as are best fitted for the purpose. The fan motor should be provided with an overload protective device and on installations where explosive dusts, fumes, or gases may be encountered, it should be of enclosed non-sparking type.

The exhaust fan in a system handling abrasive dust should be located on the clean-air side of the dust separator or protected from wear by a suitable coating. Fans handling acid gases and other corrosive materials should be constructed of suitable resistant material.

28.5 Maintenance and Testing

28.51 Responsibility for the operation and maintenance of an exhaust system should be placed in the hands of one man. His duties should include: (1) Routine inspection and repair or replacement of worn and damaged parts; (2) proper maintenance of the fan and other moving parts; (3) operation of the air-cleaning equipment in accordance with the instructions of the designing engineer and the manufacturer of the equipment; (4) instruction to the workers in the proper use of the system for maximum safety and comfort; (5) report to proper plant executive any wear, non-use or abuse of facilities.

28.52 Method of Testing Exhaust System for Efficiency of Operation.

The measurement of concentration of polluting material in the atmosphere of the plant constitutes the basic means of measuring the effectiveness of control secured by an exhaust system. Suitable methods of sampling and measurement must be employed and the results compared with certain standards of permissible concentration of the contaminating substance.

A few tests cannot be relied upon to give a true measure of control over a long period of time. Re-testing on a routine schedule is also necessary.

It is essential to make certain (1) that the design is fundamentally sound; (2) that the system is operated in accordance with the instructions of the designing engineer and the manufacturer of the equipment; (3) that the system is properly maintained.

28.53 Measurement of Airflow

Routine measurement of airflow through the system shows whether it is operating in accordance with the original design the determination of the static suction at various hoods is helpful as an index of operation and maintenance but in addition it is recommended that an airflow meter be provided in the main line to indicate the total flow. A pitot-static tube may be employed for this purpose; its advantages are simplicity of operation and zero resistance, but the instrument is troublesome in a dust exhaust system because the pressure-openings become plugged with dust. A venturi section in the main pipe provides a permanent meter without great cost and does not introduce excessive resistance when properly designed.

29. Explosive Vapors and Gases

29.1 Storage

Where 5 gallons or more of liquids which give off flammable vapors at ordinary temperatures are kept, the main supply should be stored in a buried tank located outside the building and the working supply should be pumped into the building as needed. When this pump is stopped, all the liquids in the pipe should flow back into the supply tank. Where a buried tank and pump cannot be used, the main supply should be stored outside and well away from other buildings and should be kept covered and under lock and key.

Inert gas systems, which prevent mixture of air with the gases of flammable liquids in storage, are recommended.

Note: Among the common liquids giving off flammable vapors which are explosive when mixed in the proper proportions with air are: gasoline, naphtha, benzine, benzol, toluol, xylol, amyl acetate (banana oil), carbon di-sulphide, alcohols, ethers and acetones. The majority of so-called "volatile solvents" fall in this class, also light fuels and illuminants, and many mixtures used for cleaning and for thinning lacquers, enamels, paints and varnishes. All liquids subject to rapid evaporation should be regarded with suspicion unless their constituents are definitely known and understood.

It should be kept in mind that most solvent vapors are heavier than air and so have a tendency to flow toward lower levels and pocket in sumps, basements and other depressions.

29.2 Safety cans of 5 gallons capacity or smaller should be used for distributing the liquid to working places where small amounts are used. Systems and appliances approved by the Underwriters' Laboratories offer specifications for these and greater requirements.

29.3 Ignition Hazards

Smoking and the possession of matches or other flame producing articles should be prohibited in areas where explosive materials are used, stored or generated.

Open lights or flames, switches, motors or other electrical equipment (except those provided with approved vapor-proof enclosures) should not be permitted where hazards are present through:

Artificial Leather Manufacturing
Degreasing of Skins (with gasoline or benzine)
Dipping or Cleaning (with liquids listed above)
Japan Mixing
Lacquer Manufacturing
Nitrocellulose Film Storage
Rubber Cement Mixing
Spray Painting
Dip Coating and Oven Drying

Coal, Grain, or Starch Dusts
Or wherever explosive vapors, gases or dusts are present.
Incandescent lights of the double globe keyless type should be used to provide illumination.

29.4 Static Electricity
Effective means of diffusing charges of static electricity shall be provided, such as:
Maintaining the moisture content of the air at not less than 60 per cent relative humidity.
Bonding and grounding of all metallic parts.
Provision of brush collectors or other effective means of removing static electricity from moving belts.
Use of non-conducting materials, if possible, is recommended where conditions are such that static electricity charges may accumulate.

30. Spray Coating

30.1 Hazards
The hazards which may be incident to spray coating operations are of two general types:
(a) Fire and explosion hazards due to the presence of a finely divided mist of highly flammable material.
(b) Health hazards due to the presence of potentially harmful substances such as lead, benzol and silica.
(c) Health hazards from finely divided metals in metal spraying.

30.2 Precautions
The following recommendations represent the minimum precautions considered advisable for spray coating operations.

30.21 For Spray Coating Operations of All Types
Spray coating should be conducted in segregated booths or rooms, and a separate booth should be provided for each spraying operation.
Adequate exhaust ventilation should be provided for all spraying operations. The equipment should be so arranged that fan motors are outside of the exhaust ducts and do not come in contact with vapor-laden air.
Good housekeeping is essential, and should include a systematic daily cleaning schedule.
It is suggested that the inside of spray booths may be coated with fire resistive greased paper, green soap, vaseline or whiting and glycerine, to facilitate the removal of deposited paint or its equivalent by means of hose and water.

30.22 For Spray Coating with Materials Containing Flammable Substance.
Exit facilities should be adequate to insure the quick egress of all employees in case of a flash, fire, or explosion.
Each spray room or booth should be provided with separate, self-contained exhaust system, not connected at any point

to the exhaust ducts from any other room or booth so as to avoid the possibility of fire flashing from one room or booth to another through exhaust ducts terminating in a common header.

In general, machinery, motors and switches should be located outside of spraying departments, but, if so located, they should be subject to emergency control within the department. Non-ferrous fan blades and cleaning tools should be used.

Electric motors, switches, wiring, lighting fixtures, etc., should be of types approved for use in explosive atmospheres.

All exposed metal parts such as piping, frames, etc., should be effectively grounded.

Lighting fixtures should preferably be located outside of the spray booth or compartment. Sockets should be of the keyless type and both sockets and lamps should be enclosed in vapor-proof globes.

Fire protection apparatus, extinguishers, sprinkler systems, etc., should be provided and should be kept ready for immediate use.

Smoking, and the possession of matches, by all employees engaged in spray coating operations should be prohibited.

Supplies of coating materials, solvents and diluents in excess of those required for immediate use should be stored remote from the spraying department.

The intake for the air compressor should be direct from the outside atmosphere or located a safe distance from the spraying operations.

30.23 For Spray Coating with Materials Containing Harmful Substances.

Approved respirators, preferably of the positive air pressure type and drawing air from an uncontaminated source, should be worn by all employees engaged in spray coating operations. The term "approved respirators," as used herein, means those approved by the United States Bureau of Mines for the specific service under consideration.

Coating materials free from benzol, lead and silica should be used wherever possible.

To prevent the ingestion of lead, adequate washing facilities should be provided and used, and eating or chewing in the spraying department should be strictly prohibited.

Goggles, gloves and aprons should be provided and used when necessary.

31. Tank Operations

32. Acids and Caustic Liquids

32.1 Storage tanks for dangerous liquids should be so located that possibility of injury to persons through tank failure is minimized.

Storage tanks should be so installed as to provide opportunity for complete inspection. Concrete foundations are recommended.

32.2 Strong acids and caustic liquids should be handled in bulk by the following methods only:

Gravity systems
Compressed air or inert gas displacement systems
Pressure pump systems

Wherever possible these systems should extend to working spaces so that it will be unnecessary to carry such liquids in small containers.

32.3 Carboys, Jugs and Bottles

Carboys, hermetically sealed, may be under internal pressure at high temperatures, and should not, therefore, be stored where exposed to direct sunlight or other sources of excessive heat.

The condition of the wooden containers of newly received acid carboys should be checked.

When small quantities of acids or caustic liquids must be handled manually, carboy trucks, safe containers, inclinators and bottle carriers should be provided. Unboxed carboys should not be used and air pressure should not be applied to carboys. Carboys should be emptied only by means of an inclinator, or by means of a pump which, without causing either suction or pressure in the bottle, draws the liquid from it. When carboys are empty, they should be rinsed out with water and drained. Before adding water, carboys should be inverted to make absolutely sure that they are empty.

32.4 Protective Clothing

Operators engaged in handling corrosive liquids, repairing pipe lines, etc., should be provided with goggles and rubber gloves, and, where necessary, with rubber aprons and boots. It is desirable that shower heads equipped with quick operating valves be provided in areas where acids are handled.

32.5 Repair of Acid and Caustic Liquid Lines, Pumps, Etc.

Before being dismantled pipe lines, pumps, etc., which are to be repaired should be drained, blown down with compressed air, relieved of all pressure and kept free from pressure. Particular attention should be paid to branch lines where pockets may exist.

All pumping on the system with which parts under repair are connected should be stopped unless blank flanges are installed in lines to segregate such parts from the pumps.

A flange connection should be broken by being covered with a shield of sheet lead or rubber through which the wedge should be driven.

After completion of a repair job, all spillage or liquids shall be thoroughly washed away with water.

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ACKNOWLEDGMENT

The courtesy of the Employers Mutual Insurance Company of Waukon, Wisconsin and their Safety Engineer, Mr. Bruce W. Freet, during the survey of the Industrial Education Shops is appreciated.